SCIENCE

FRIDAY, MARCH 7, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

PHYSICS AND DAILY LIFE[1]

THE school system of Germany has often been held up to the teachers of this country as a model of perfection. Germany has been called a nation of schoolmasters, and the wonderful progress of its industries has been attributed in no small measure to the rigid training and high efficiency of its gymnasia, its universities and its vocational schools. Even at the present moment our country is being urged on many sides to establish alongside the regular public secondary schools an independent system of vocational schools, the chief argument in favor of this plan being the fact that it was "made in Germany."

Notwithstanding the fact that the reputation of the German schools is so brilliant on this side of the Atlantic, there are many thoughtful and earnest dwellers in the Fatherland who consider the training given by their schools to be of very doubtful educational value. Thus, some twenty years ago Emperor William II. called a congress of the leading schoolmen of Germany to consider what could be done to bridge the chasm that yawned so wide and deep between the work of the schools and the daily lives of the pupils. Little was accomplished as the result of this congress. The schoolmen declared it were little short of sacrilege to experiment with schools, which had always enjoyed a reputation for perfection equaled only by that of the medieval monks. Since that time, the vocational and industrial schools of Germany have developed alongside and, in large

[1] Presented at the conference of the University of Illinois with the secondary schools of the state, November 22, 1912.

measure, independent of the "regular" schools. This unfortunate double system of public schools was made necessary because of two relentless and irreconcilable facts: namely, (1) the needs of the people; and (2) the "conservatism" of the schoolmen.

In spite of the fact that the vocational schools of Germany did bring education and life nearer together for the working classes, the children of the intellectual classes continued their double existence in the world and in the school respectively until very recently. Day has, however, now begun to dawn on the academic landscape, and efforts, which originated among the teachers of science, are now being made to establish some semblance of a relationship between the school routine and the daily lives of the pupils. The evils that are being eliminated are over-systematization, rigid uniformity and the belief that words, signs and symbols can be made to serve in the educational process in place of concrete materials and real problems.[2]

Many will doubtless recognize the similarity between the experiences of Germany and those through which this country is now passing in the matter of bringing school and life to have something in common besides the children themselves. The needs of the masses for vocational schools are only equaled by the needs of the pupils in the regular schools for mental pabulum that nourishes them and helps develop their characters. Can you doubt this in the face of trustworthy reports, like that of the City Club of Chicago, which show that the present public school system fails to reach more than half of the school population? If so, study the statistics of elimination and retardation and be impressed by the enormous annual waste in material resources thus caused—the much more impressive and disastrous waste in human resources can never be calculated.

In this state of Illinois, as you all know, the crisis is imminent. The state legislature is considering a bill for the authorization of a second independent system of schools, intended in some measure to atone for the shortcomings of the present public schools. The chief argument in favor of the proposed plan is that the schoolmen who are now in control are both incompetent and unwilling to reorganize their work so as to meet the needs of that half of the school population which is not benefited in any marked degree by the present system. In support of their argument, Germany is held before us as a model, and we are urged that, as it is in the Fatherland, so must it be here. In other words, the incompetency of the teachers in permitting the proven inefficiency of the schools to continue is condoned, and we are invited to authorize additional expenditures on the ground that others, not schoolmen, can succeed where we have failed.

What would a captain of industry think of an analogous proposition with regard to his manufacturing plant? Suppose that a plant and its employees wasted half of the raw material supplied to it; would the manager enlarge the plant and take on more hands of a different sort in an endeavor to reclaim some part of the original waste? Yet the idea is abroad that this sort of a procedure, obviously absurd in an industrial enterprise, is, nevertheless, justified in school practise. The basis for this idea seems to be the fact that teachers are supposed to be so conservative that they are unwilling even to consider a new idea, much less to adopt it.

We teachers, naturally enough, repudi-

[2] Ostwald, "Wider das Schulelend," Leipzig, 1909; Gutzmer, "Die Tätigkeit der Unterrichtskommission der Gesellschaft deutscher Naturforscher und Aerzte," Leipzig, 1908.

ate this accusation. We pride ourselves on being the most progressive of all people. Do we not all use our last bit of strength to keep up to date? Yet, where there is so much smoke, there must be some fire. It behooves us then not merely flatly to deny the charge, but rather to analyze carefully our methods and results in the effort frankly to discover wherein we have given ground for popular misconceptions.

This analysis might be found to be a difficult, not to say embarrassing, undertaking if it were not that the problem may be stated in a somewhat different way which permits of a ready answer. Instead of asking what grounds we have given for a reputation of ultra-conservatism, we may ask whether we have as yet succeeded in bringing the school work close to the lives of the pupils. After graduation our education and our lives are most inextricably entangled. Is it so before graduation? For if it is, the problem of vocational education vanishes. If the life of the child is his education, or if his education is his real life, he is developing to serve society to the full extent of his abilities. But if this is not true, if his schooling and his life are to him two strangely incompatible forms of existence, then there is something radically wrong with the school. Are we then making education and life a unified existence for the pupils?

The answer to this question must be an unequivocal *No.* The simple fact that this conference and other similar conferences all over the country are considering how to bring schoolwork close to child life is complete proof of the correctness of this answer. We teachers stand convicted by our own acts. We recognize that we fail at this vital point.

But even though we fail, are we willing and ready to improve and constantly to work for a closer union of education and life? Here the answer is equivocal: some are, and some are not. Some are willing to try, but are placed in circumstances where they are not free to make the effort. They are blocked by the authority that works from above downward—particularly the latter. Others express in words their willingness to make the trial, but continue in deeds to run along in the same old rut. Still others are eager to break away from the present system and to strive for a more efficient one, but they do not know where to begin. In the hope of helping such as these in gaining a vantage-ground from which to work for the union of education and life, the following hints are given. They constitute a brief summary of the main points of agreement among those who have in some measure succeeded in breaking loose from tradition and from the vested interests of school paraphernalia and equipment.

The first of the false gods that holds and will forever hold education and life asunder is the idol of uniformity. How this graven image ever came to be given an honorable place in the temple of learning passeth all human understanding. The genius of a man, the characteristics that mark him off from his fellow men and give him his priceless personality, are his individual differences. It is because he has traits and combinations of traits which are different from those of any other man that he is interesting and powerful or weak, as the case may be. In life, it is his individual differences that mark him for success or failure, but in school these must be ignored and blighted. "Every one is best trained for his greatest usefulness in life by destroying his individual differences, by putting him through the same intellectual mill with every one else"; so says the idol of uniformity.

The absurdity of this idea in general needs not to be expanded here. It has

been recognized, and efforts have been made to suppress it as far as programs of study go. Thus there are the classical courses, the scientific courses, the technical courses, each of which is supposed to minister to a definite type of mind. But here again the idol has but been broken into smaller pieces, each fashioned after the form of the whole. This arrangement has again proven unsatisfactory, and the elective system has done much to shatter it. A perfectly rigid course is found at present only in highly specialized professional schools.

But the idol of uniformity still persists in the specifications of each single course. It is manifestly so great an administrative convenience to have a unit of physics mean the same thing—at least superficially—whether the work is done in Florida or in Oregon. So the idol has been shattered into still smaller fragments and each of these, fashioned in the likeness of the original, sits enthroned in some class-room. In this diminutive, unobtrusive, almost unnoticed form, the idol still holds sway over the greater part of the work of the schools. We have become so used to him that we do not recognize the fact that he sits between us and our goal, and effectively prevents our bringing about the long-sought union between education and life.

Is it any less absurd to suppose that every class in physics can be taught successfully in one set way, than it is to imagine that every mind can be trained successfully by the same grind or every malady cured by the same treatment? The experiences in the lives of the children of New York City and of those in Urbana are very different. Can one and the same physics be doled out to both with any hope of bringing physics close to the daily lives of both? Certainly not; any more than you can grow oranges and bananas at the North Pole. Then why do teachers usually take great pride in the nearness with which their course coincides with the standardized forms set up by social convention in defiance of the natural processes of the youthful mind? Were it not far better to take pride in the close adaptation of a course to the needs of the environment in which it is given? Hence the first essential for bringing physics close to the daily life is that the teachers free themselves from the servitude of this idol of uniformity. We must become iconoclasts long enough to smash these diminutive images into fragments.

The *credo* of the idol of uniformity is the syllabus. Strange as it may seem, there are numerous syllabi, all claiming to be authentic. When not enforced by some *pontifex maximus* of the idol of uniformity, these syllabi are fairly harmless. Their chief danger lies in the fact that they tend to focus the attention of teachers on subject matter. In this the syllabus is a just possession of the idol of uniformity, since the latter is only an image, possessing, it is true, the form of a man, but devoid of life, of soul, of spirit. Therefore following the precepts of a syllabus gives a merely superficial uniformity—it creates an external resemblance among physics courses, but does not necessarily assure them an inner similarity, a spirit of investigation, clear judgment, scientific imagination, or unity. In the matter of bringing education close to life, syllabi are as useless as the idol that inspired them.

Once we have freed our minds from the obsession of the idol of uniformity, we are ready to advance to the organization of a course of study that will have some chance of bringing physics and the daily life of the pupils who are to pursue it into close union. It is, however, useless to make outlines until we are well rid of the idol. Assuming that this has been accomplished,

there is one characteristic of the course which is of the most fundamental importance for the purpose in hand, and this is what may be called the philosophy of the course. This determines the point of view or general attitude toward the subject and also settles the method of presentation. Taken as a whole, the philosophy determines the value of the course as a contribution to the mental development of the pupils. If this philosophy is of the right sort, the choice of subject matter is of secondary importance; for then physics enters into the pupil's life as an integral part and creates an attitude toward science and an ability to solve problems scientifically. This attitude and this ability once secured, the pupil will be able to read and experiment intelligently for himself and so to extend his knowledge of the subject as occasion may require. We will try to define this philosophy in such a way that teachers may be helped in discriminating between a weak course and one likely to be of great strength in uniting education with life.

The idea that there is such a thing as the philosophy of a course of study is probably new to most schoolmen, because syllabi and college entrance requirements have so accustomed us to look only at the external form or index of subject matter as defining the excellence of a course that we have failed to notice its far more important internal organization. For the sake of making clear what is meant by the philosophy of a course, and in the hope of attracting your attention to this most fundamentally weighty problem, three types of philosophy of physics courses will be briefly outlined.

The first is the old stand-by which was expressed in the college-entrance statement that physics should teach the "laws and principles of elementary physics." With this end in view, the topics demanded by the college syllabus were sorted out under the heads Mechanics, Heat, Sound, Light and Electricity. The topics that fell under each head were then arranged in what adult teachers considered their order of simplicity. Thus in mechanics, the order was: Centimeter, Gram, Second. These were duly defined without giving the pupil any clue as to what he was to do with them. These simple elements were then compounded in various ways into meters, square centimeters, centimeters per second, grams per cubic centimeter, and so on. The distinction between mass and weight was always carefully made, and each item was carefully memorized so as to be available at the next examination.

In electricity, in like manner, we must begin with the electric charge obtained by rubbing a glass rod with the skin of an unfortunate cat—obscure and pitiful victim of science! Then followed the action of two charges on each other, with descriptions of the various stunts which the two charges could be made to perform—how they could be imprisoned and released, multiplied, divided or annihilated, as the case might be. In all of this the topics were merely described and experiments presented which might serve to illustrate them and make them concrete.

This organization of the course is generally called the "logical" order because it proceeds from what is to the adult physicist simple to what is to him complex. The philosophy back of it may be called the encyclopedic philosophy. In this type of instruction there is usually little unity, no repetition and no problems that are real to the pupils. The victims usually gained from it a hodge-podge of jumbled memories, a few catch phrases which they could not use rationally, and no ability in solving scientifically the real problems of their daily lives.

This method of teaching was dominant in physics courses from about 1890 to 1905. During this period physics justly became one of the most unpopular subjects in the high-school curriculum. Since 1905 its influence has rapidly declined for two reasons: namely, first, it overreached itself by so increasing the number of topics included in the course that it became impossible for the pupils to make even a faint pretense of memorizing them all; and second, the physics teachers themselves came to realize its inadequacy and arose in revolt and overthrew it.

The chief reasons for its inadequacy were these: (1) It gave no unity to the course, since it failed to group the topics about the great principles of physics but contented itself with the superficial classification of subjects under the heads mechanics, heat, and so on. On this account, it gave little chance for the repetition which is so necessary for the successful mastery of a subject. It also furnished little perspective among the large range of topics treated. Artesian wells seemed to the learner as important as the principle of action and reaction. (2) It took slight account of the daily lives of the pupils. Physics was a "disciplinary" subject, forsooth, like mathematics and Latin, and the more distasteful it was to the pupils the greater the benefit derived from it. (3) It conceived the mission of physics to be didactic—to teach the pupils the last word on each topic—rather than to help them to solve problems of their own making. Principles and facts were merely stated, explained, illustrated with strange experiments, and applied to utterly abstract problems like finding the number of dynes that would give a mass of ten grams an acceleration of ten centimeters per second. On this account it failed to appeal to the pupils, so that they were not motivated to act on their own initiatives.

Fortunately for the children, this encyclopedic philosophy has been, as stated, rapidly declining in influence since about 1905. There are at present two other philosophies, very different from each other, which are striving to replace it. The physics teacher must choose between these two, since he can not adopt both. The first of these is not so very different from the older one. Its motto may be expressed in the words: "The first course should give the pupils a general survey of the whole field of physics." In accordance with this motto, it advocates including in the first course something of everything, thereby retaining the old fallacy of too many topics. It, however, seeks to unify the topics by stringing them on the large theories and hypotheses of physics. Thus, the pressure of gases, evaporation, expansion by heat and electrolysis are not isolated phenomena, but are nothing but the results which the normal actions of molecules and atoms would, of course, produce. The phenomena of light do not consist of the familiar facts of vision, but are evidently and simply the effects which any one would expect electromagnetic undulations in an imponderable luminiferous ether to produce. The pupils need not learn clearly and definitely what light actually does in their daily lives, but rather must master the mechanisms which genial physicists have constructed to aid them in picturing how these effects might be brought about.

In this method the daily lives of the pupils plays a relatively subordinate part. Familiar experiences are introduced after the clever mechanisms of the wily physicists have been duly set forth. For example, all matter consists of molecules in motion. When a dish of water stands on the table, the molecules of water under the surface are more crowded together than those above the surface. At the surface

water molecules are flying off into the air and back from the air into the water. But under these conditions more molecules fly from water into air than the reverse; hence the water gradually disappears from the dish. Heat is nothing but molecular kinetic energy. If the water is heated, evidently the kinetic energy of the water molecules is increased. They therefore disappear into the air more rapidly than before, and the dish dries up more quickly. If a bell jar be placed over the dish of water, the molecules of water can not spread over the entire room, but are constrained to butt their heads against the jar. We should expect these impacts to produce a pressure on the inner walls of the jar. After a time a condition is reached in which just as many molecules fly from the water into the air as fly from the air into the water. Then evaporation should cease. We find that it does so. Under these conditions the water vapor in the jar is said to be saturated.

This second method of teaching thus seeks to interpret phenomena to beginners not in terms of immediate concepts like wet, dry, pounds, inches, pressure and the like, but in terms of less immediate abstract concepts like molecules, atom, imponderable ether, and so on. Here, again, the effort is made to impress on the pupils conceptions and interpretations which may be wholly concrete to specialists in physics, but which are totally abstract to beginners, especially those of school age. For this reason this type may be called the theoretical or abstract method.

It will be noted that this theoretical or abstract method has much in common with the encyclopedic philosophy, especially as regards method of presenting topics. It is of necessity didactic in spirit, since it proposes to impose on the pupils, not the laws and principles of physics, but a survey of the whole field, consisting in the last analysis of the theories and working hypotheses of physics. It, therefore, does not encourage originality, initiative and creative imagination, since the system which it seeks to implant has already been worked out by the masters and is so comprehensive that the pupils have to be crowded in order to cover it all in the allotted time. The pupils are thus very apt to pick up the terminology of the system long before the terms stand for anything really concrete to them and they use this terminology freely to cover up their real ignorance of how best to control the forces of nature under a given set of real conditions.

In the courses of this type you will seldom find a topic introduced by a daily experience or by a problem that arises from daily experience. These, to the pupils real and concrete things, are usually placed last under the head of applications. You will often find in these courses topics introduced by laboratory or lecture experiments; but most of these are, for beginners, little less abstract than the dynes, atoms and unit poles into which they are deftly resolved by the teacher. A thing is not concrete to a pupil merely because it is made of matter; it is concrete only when it easily associates itself with the concepts and ideas already present in his mind as the result of his previous experiences.

The abstract philosophy has developed courses that are better organized than the older courses, in that they possess greater unity. They suffer, nevertheless, from many of the faults of the former because they overemphasize the value of physical theory to beginners, and so seek to impose a ready-made system on the pupils without justifying this procedure in advance. Whatever advantages this method may be supposed to have in preparing pupils for later work in some colleges and technical

schools, the over-emphasis of physical theory carries with it an under-emphasis of the daily experiences, and this renders courses of this type little adapted to bringing physics close to daily life. Those who adopt this philosophy may not expect to contribute much to the solution of the problem before us. Their work but adds weight to the demands of that vast majority of our people who must earn their livelihood by controlling the forces of their physical surroundings and solving life's practical problems in the most scientific way.

The other philosophy which is now contending with the abstract for a controlling voice in the organization of physics courses for beginners is quite different from that just discussed. This third system places neither the laws and principles of physics, nor yet the theories and hypotheses of the science at the center of its system. Instead of these human interpretations of phenomena, it centers its ideas about the development to the utmost of the powers and latent abilities of that hope of the future of our nation, the human child himself. It holds that physics does not exist in the schools for the purpose of familiarizing young people with either the laws or the theories of physics; but rather for the sake of helping the pupils to increase their powers of controlling their physical environment intelligently and solving their life's problems rationally. If this help is wisely given, they will, of course, learn the most fundamental facts and generalizations of physics; and they will learn them not as theoretical mechanisms which may help them to imagine how phenomena might be "explained," but as practical knowledge which will help them to control the forces of nature in daily life. Because of the nature of its central idea, this type may be called the practical or concrete philosophy.

This concrete philosophy demands a very different method of treatment from that developed by the other two. The most important differences consist in introducing each topic by means of daily experiences of the pupils of each class, in discussing these topics at the outset by the methods of reasoning with which the pupils are already familiar, in working in both class room and laboratory with materials and apparatus which are in common use outside of physics classes, and in leading to conclusions which are expressed in concrete terms, like pounds and feet, rather than in abstract terms, like atoms and ether.

This method thus takes the child as he is, and seeks to enlarge his fund of information concerning what the things about him will actually do, and to increase his powers of controlling his physical surroundings. Signs and symbols are not introduced until a need for them has arisen and the ideas for which they stand have become fairly concrete by wide association with previous concrete ideas. Theories are not expounded until the pupils have acquired a broad and definite knowledge of the facts and laws which the theories are invented to explain.

The concrete philosophy thus demands an arrangement which begins where that required by the others ends, namely, with the daily life; and ends where the others would begin, with the laws and theories of physics. It lays great weight on having the pupils at the beginning of their course work much with familiar things in ways familiar to them, and insists on their solving many problems of their own making by experiments with apparatus and machines of the sort used in the world's work. It seeks to lead the pupils gradually from the crude intellectual manners with which they come to the physics classes to the more refined and rigorous methods of think-

ing with which they should leave them, at the same time gradually increasing their fund of concrete, definite, dependable and useful information.

This method makes it possible to master fewer principles in a given time; but, as the psychologists have conclusively proved, assures the pupils of a much greater chance of retaining both the subject matter studied and the methods of reasoning used as real helps in solving the real problems of later life. In other words, the method demanded by the practical philosophy is the one that assures us of giving the greatest amount of transferable training.[3]

In order to fix in mind the differences among the three types of method just described, the following three samples of treatment are given. They are typical of the way in which the subject of light may be introduced in accordance with the three types of physical philosophy.

I. *Encyclopedic.*—A luminous body is one that emits light. A medium is any substance through which light passes. A transparent body is one that obstructs light so little that we can see objects through it. A translucent body is one that lets some light pass, but not enough to render objects visible through it. An opaque body is one that does not transmit light. A ray of light is a single line of light. A pencil or beam of light is a collection of rays, which may be parallel, diverging or converging; it may be traced in a dark room into which a sunbeam is admitted by the floating particles of dust which reflect the light to the eye.

The visual angle is the angle formed at the eye by rays coming from the extremities of an object. Knowing the distance of a body, we immediately estimate its size by the visual angle.

Laws of Light. (1) Light passes off from a luminous body equally in all directions. (2) Light travels through a uniform medium in straight lines. (3) The intensity of light decreases as the square of the distance increases.

II. *Abstract.*—Just as sound is defined as undulations in the air, or some other medium, that produce the sensation we call sound, so light, in the same sense, consists of undulations or waves in a medium that produce the sensation called light. Physicists have agreed to call this medium which transmits light the ether. It exists everywhere, even penetrating between the molecules and atoms of ordinary matter. Nothing is known about its nature and but little concerning the exact way in which light travels through it; but the masters of science generally agree that light is a wave motion in the ether, and that the vibrations of these waves are not longitudinal as in sound waves, but transverse. The transverse disturbances by means of which the waves are propagated are probably not transverse physical movements of the ether, but transverse alterations in its electrical and magnetic conditions.

A transparent body is one which allows light to pass through it with so little loss that objects can easily be distinguished through it. Examples of transparent bodies are glass, air, water. A body is translucent when it transmits light so imperfectly that objects can not be seen distinctly through it. Such bodies are horn, oiled paper, thin sheets of wood. Opaque bodies are those which transmit no light, as brick, pig iron, wooden boards. No sharp line of separation between these classes can be drawn; the classification is one of degree.

III. *Concrete.*—If a number of people

[3] For a more detailed discussion of this point, see Mann, "The Teaching of Physics for Purposes of General Education," Chap. VII.-X. New York, Macmillan, 1912.

are asked how large the moon looks, each will give a different answer. One may say that it looks as large as a dime, another that it seems as large as a saucer, while a third may say that it looks as large as a cart wheel. Then, too, the moon looks larger to every one when it is near the horizon than when it is high in the sky.

Infants reach for the moon and cry because they can not get it. Landsmen find it very difficult to estimate the distance between two boats at sea. On the other hand, when we look at a man climbing a distant hill, he appears as but a small speck on the landscape, yet we estimate his size correctly. We even use our knowledge of the man's size to estimate the distance or actual size of the hill or the height of the trees there. Ability to estimate distances and sizes from the way things look is obtained from long practise. Let us see if we can find the reasons for these things.

When sunlight streams through the window, it traces an outline of the window on the floor. If you hold your open hand so that the sunlight falls vertically upon it, the outline of the shadow cast on the floor resembles the outline of the hand. Most of us have amused ourselves making shadow pictures, by so placing the hands between a lamp and the wall that the shadow on the wall resembled a rabbit, a goose, a clown, or any other creature. We might draw the same outline by pivoting one end of a long straight pencil at the source of light, and moving it around the edges of the object, while the other end marked on a paper suitably placed. We can think of such a pencil as if it were the beam from a tiny searchlight moving about the edges of the object and tracing the outline.

When a sunbeam is allowed to enter a darkened room through a small opening, its path, as revealed by the dust particles in the air, is seen to be a straight line. Where it falls on some object it makes a bright spot. The sun, the opening, and the bright spot all lie on the same straight line; so from inside the darkened room we can determine the direction of the sun with reference to objects in the room, by means of the line drawn from the center of the bright spot through the center of the opening. Because light travels in straight lines, we judge the direction of an object by observing the direction in which light from the object travels.

Whatever you may think of the relative merits of the three types of method just outlined, it is clear that the only way to bring physics close to daily life is to bring daily life close to physics. The only method that assures the teacher of doing this successfully is that of the practical or concrete philosophy. It is possible that other methods may be more successful when the aim is to prepare students to meet past or present college entrance requirements, or to pursue later courses in some of the technical schools. Other methods can not, however, compete with the concrete method when the aim of the teaching is the union of education and life. Each teacher must, therefore, choose his own aim and adapt his methods to suit it. Let me in closing remind you of the importance of the choice. Had education and life been united long ago, the schools would not now stand discredited, nor would the demand for separate vocational schools have arisen. A union now of education and life will save the situation.

C. R. Mann

The University of Chicago

ON THE APPEARANCE OF HELIUM AND NEON IN VACUUM TUBES[1]

At the last meeting of the Chemical Society, Sir William Ramsay, Prof. Collie,

[1] From *Nature*.

and Mr. Patterson described some experiments which they regard as proving the transmutation of other elements into helium and neon. I have been making experiments of a somewhat similar character for some time, and though the investigation is not yet finished, the results I have obtained up to the present time seem to me in favor of a different explanation from that put forward at the Chemical Society. I described some of these experiments in a lecture at the Royal Institution on January 17, but as the separate copies of that lecture have not yet been issued, I will give here an account of some of the experiments which seem to me to have the most direct bearing on the phenomenon in question.

I used the method of positive rays to detect the gases; this method is more sensitive than spectrum analysis, and furnishes much more definite information. I may say that the primary object of my experiments was to investigate the origin and properties of a new gas of atomic weight 3, which I shall call X_3, which I discovered by the positive-ray method. This gas, as well as one with an atomic weight 20 (neon?), has appeared sporadically on the photographs taken in the course of the last two years; the discharge in the tube being the ordinary discharge produced by an induction coil through a large bulb furnished with aluminium terminals, and containing gas at a very low pressure. There seems to be no obvious connection between the appearance of either of these lines and the nature of the gas used to fill the tube; the 3 line has appeared when the bulb was filled with hydrogen, with nitrogen, with air, with helium, or with mixtures of hydrogen and oxygen in various proportions; the 20 line when the bulb contained hydrogen, nitrogen, air, hydrochloric acid gas, mixtures of hydrogen and oxygen.

The experiments I made had for their object the discovery of the circumstances which favor the production of X_2, and to test whether it was triatomic hydrogen produced by the discharge, as this is the alternative to its being a new element. I have found that the conditions which lead to a considerable production of X_3 generally give rise to the appearance of helium and neon. Indeed, in the great majority of cases in which I have observed the appearance of traces of helium and neon these gases have been accompanied by larger quantities of X_3; this gas seems to have escaped the notice of the readers of the paper at the Chemical Society. I may mention, too, that along with neon of atomic weight 20 there is a line in these circumstances corresponding to an atomic weight 10 or thereabouts. Though this is probably due to neon with two charges of electricity, it is generally brighter in comparison with the neon line than is usual for the lines corresponding to doubly and singly charged atoms, so that it is not impossible, though perhaps unlikely, that it may be due to a new gas.

The positive rays for the analysis of the gases were produced in a vessel containing gases at a low pressure. I shall call this the testing vessel; the vessel in which the various processes for generating X_3 were tried (the experimenting chamber) was sealed on to the testing vessel, but separated from it by a tap. Thus the pressure in the experimenting chamber was not restricted to being the same as that in the testing vessel, but might have the value which seemed most appropriate for any particular type of experiment. After these experiments were over, the tap was turned and some of the gases from the experimenting chamber let into the testing vessel; a photograph was then taken, and by comparing it with one taken before turning the

tap the new gases present in the experiment chamber could be detected. The processes by which I have hitherto got the most plentiful supply of X_3 are:

(1) By bombarding with kathode rays metals and other bodies.

(2) By the discharge from a Wehnelt kathode through a gas at a low pressure.

(3) By an arc discharge in a gas at a comparatively high pressure.

By far the larger number of the experiments were made by bombarding metals, but I will begin by describing an experiment with the arc, as it raises the question of the origin of these lines in a very direct way. An arc between iron wires passed through hydrogen at about 3 cm. pressure (in this case all the kathode rays would be absorbed quite close to the electrode) for an hour or so, and the gases liberated in the experimenting chamber tested; X_3, helium, and neon were found. The experiment, using the same wires for terminals, was repeated the next day; the three gases were again found. On the next day, still using the same wires, the arc was passed through oxygen; the X_3 line was still there, though much fainter than before; the helium and neon could not be detected with certainty. The next day, using the same terminals, the arc was again passed through oxygen; not one of the lines could be detected. This looks as if these substances were produced by the arc passing through hydrogen. It was found, however, that, still keeping to the same terminals, on pumping the oxygen carefully out and filling up again with hydrogen, the arc through the hydrogen now did not give even a trace of these lines. On replacing the old iron wires by new ones, and sending the arc through the hydrogen, the lines reappeared. This experiment seems to me to point very clearly to the conclusion that these gases were in the terminals to begin with, were removed from them by the long-continued sparking, and were not produced *de novo* by the arc.

In the experiments when the discharge was produced in a tube with a Wehnelt kathode, the potential difference between the terminals was only 220 volts, so that the kathode rays in the tube had only a fraction of the energy they had when the discharge was produced by an induction coil; X_3 and helium appeared when the discharge passed through this tube. I did not detect any neon.

The method which gave X_3 and also the other gases, in the greatest abundance, was to bombard metals, or indeed almost any substance, with kathode rays. The tube used for this purpose had a curved kathode, which focused the rays on a table on which the substance to be bombarded was placed. The substance, round the spot struck by the rays, was generally raised to a bright red heat by the bombardment; the bombardment was as a rule continued for five or six hours at a time. I have got the X_3 line, as a rule, accompanied at first by the helium line, and somewhat less frequently by the neon line, when these following substances (which include nearly all I have tried) were bombarded: iron, nickel, oxide of nickel, zinc, copper, various samples of lead, platinum, two meteorites, and a specimen of black mica given me by Sir James Dewar, which was remarkable for the amount of neon it gave off.

The most abundant supply of X_3 came from platinum, and I will describe an experiment with this metal. A piece of platinum foil was bombarded on four days, and the gases produced each day examined. At the end of the first day's bombardment it was found that the line due to X_3 was very strong, those due to helium and neon weaker, but still quite conspicuous. The gases produced the first day were well

washed out of the tube, and the foil bombarded for a second day. The gases formed proved to be much the same as on the first day; there was no appreciable diminution. The examination of the result of the third day's bombardment showed that the X_3 line had diminished considerably, the lines due to helium and neon perceptibly. When the gases produced on the fourth day's bombardment were examined it was found that the X_3 and helium had diminished to such an extent that the lines were barely visible. I could not see the neon line at all. In this case the helium was not eliminated until the fourth day. In general I have found that the helium disappeared long before the X_3 gas. Thus a piece of old lead I bombarded gave off appreciable quantities of helium from the first day's bombardment, very little on the second day, and none that I could detect on the third or subsequent days. The X_3, on the other hand, came off in considerable quantities up to the end of the experiment, which lasted for six days. I attribute the superior elimination of X_3 in the case of the platinum foil to the fact that during the whole time the bombardment was concentrated on a patch only about 2 mm. in diameter, while the lead melted under the bombardment, so that fresh portions were continually being exposed to the rays. A piece of Kahlbaum's chemically pure lead gave appreciable amounts of X_3 and helium, though not nearly so much as the old lead. I tried some lead which had just been precipitated, but could not detect either X_3 or helium.

In the course of the experiments with old lead I let hydrogen into the experimenting chamber to see if it would increase the amount of X_3, but could not detect any effect. On one occasion I let in oxygen when nickel was bombarded, also without any appreciable effect. I think these experiments are in favor of the view that these gases are present in the metal independently of the bombardment, and are liberated by the action of the kathode rays. They are surprisingly firmly held by the metal, and can not, so far as my experience goes, be got rid of by heating. I kept a piece of lead in a quartz tube boiling in a vacuum for three or four hours, until all but a quarter of the lead had boiled away, and examined the gases given off during this process; neither X_3 nor helium could be detected. I then took the quarter that remained and bombarded it, and got appreciable amounts of X_3 and helium. On a second bombardment the X_3 was visible but the helium had disappeared. As an instance of the way these gases can stick to metals even when in solution or chemical combination, I may mention that though, as I have said, platinum foil after long exposure to kathode rays is freed from these gases, yet I got appreciable quantities of X_3 and helium, though no neon from platinum sponge freshly prepared from platinic chloride.

The reason helium is obtained by heating the glass of old Röntgen-ray bulbs is, I think, that after liberation by the kathode rays, the helium either adheres to the surface or is absorbed in a much looser way than before it was liberated. The question as to how these gases get into the metals is a most interesting one; are they absorbed in the process of manufacture? In this connection it is interesting to note that X_3 does not appear to occur to any appreciable extent in the atmosphere. Sometimes when suffering from the difficulty of clearing out these gases I have been goaded into speculating whether they do not represent the partially abortive attempts of ordinary metals to imitate the behavior of radio-active substance; but whereas in these substances the α particles and the like are emitted with such velocity

that they get clear away from the atom, in ordinary metals they have not sufficient energy to get clear, but cling to the outer parts of the atom, and have to be helped by the kathode rays to escape.

I would like to direct attention to the analogy between the effects just described and an everyday experience with discharge tubes—I mean the difficulty of getting these tubes free from hydrogen when the test is made by a sensitive method like that of the positive rays. Though you may heat the glass of the tube to melting point, may dry the gases by liquid air or cooled charcoal, and free the gases you let into the tube as carefully as you will from hydrogen, you will still get the hydrogen lines by the positive-ray method, even when the bulb has been running several hours a day for nearly a year. The only exception is when oxygen is kept continuously running through the tube, and this, I think, is due, not to lack of liberation of hydrogen, but to the oxygen combining with the small quantity of hydrogen liberated, just as it combines with the mercury vapor and causes the disappearance of the mercury lines. I think this production of hydrogen in the tube is quite analogous to the production of X_3, of helium, and of neon. I have been greatly assisted in the experiments I have described by Mr. F. W. Aston, Trinity College, and Mr. E. Everett.

J. J. Thomson

February 8

THE SMITHSONIAN AFRICAN EXPEDITION

The collections made by the Smithsonian African Expedition under the leadership of Col. Theodore Roosevelt, when received, were distributed to the various departments of the National Museum to which they pertained; the birds were sent to the bird department, the large animals to the mammal department, the plants to the botanical department, and so on.

A number of groups of the large mammals have been prepared, and a number of individual specimens mounted for exhibition purposes. Most of the specimens have been placed in the study series, and the duplicates will be distributed by exchange or otherwise.

The groups of large mammals now mounted will shortly be placed on exhibition in the new Museum mammal hall where the larger animals will be exhibited. Those that were on exhibition have been temporarily withdrawn, in order to place them in their proper place in the classification in the hall, which is closed temporarily pending the arrangement of the cases containing the specimens.

It now seems an opportune time to make a final statement relating to the expedition and with this in view the secretary recently communicated with the parties who contributed to the fund, and has thus far received replies from the following that they have no objection to their names being given to the public. In this connection the secretary wishes to state that up to this week Colonel Roosevelt has not known who the contributors were, with the exception of Mr. Carnegie and possibly one or two personal friends.

It has not been the custom of the institution to publish the names of contributors to research work or expeditions conducted under its direction until such enterprise had been completed, and only then when the contributor had no objection to such publication. The contributors include:

Mr. Edward D. Adams, of New York City.
Hon. Robert Bacon, of Boston, Mass.
Mr. Cornelius N. Bliss, of New York.
Mr. James Campbell, of St. Louis, Mo.
Mr. W. Bayard Cutting, of New York City.
Mr. Andrew Carnegie, of New York City.
Mr. Cleveland H. Dodge, of New York City.
Mr. E. H. Gary, of New York City.
Mr. John Hays Hammond, of Washington, D. C.
Col. H. L. Higginson, of Boston, Mass.
Mr. Hennen Jennings, of Washington, D. C.
Mr. J. S. Kennedy, of New York.
Mr. Ralph King, of Cleveland, Ohio.
Hon. George von L. Meyer, of Washington, D. C.
Mr. D. O. Mills, of New York.

Hon. T. H. Newberry, of Michigan.
Mr. L. L. Nunn, of Provo, Utah.
Mr. H. C. Perkins, of Washington, D. C.
Mr. George W. Perkins, of New York City.
Mr. Henry Phipps, of New York City.
Mrs. Whitelaw Reid, of New York City.
Hon. Elihu Root, of Washington, D. C.
Mr. J. C. Rosengarten, of Philadelphia, Pa.
Mr. Jacob H. Schiff, of New York City.
Mr. Isaac N. Seligman, of New York City.
Mr. O. M. Stafford, of Cleveland, Ohio.
Hon. Oscar S. Straus, of New York City.
Mr. Isidor Straus, of New York.

From the contributions, the Smithsonian's three fifths share of all the expenses were paid; the other two fifths were paid by Colonel Roosevelt, which covered all his personal expenses and those of his son, and their proportionate two fifths share of the total expenses of the expedition.

The following is the complete list of the collections made by the expedition that have been received by the institution:

	Specimens
Mammals	5,013
Birds	4,453
Birds' eggs and nests	131
Reptiles and batrachians	2,322
Fish	447
Plants	5,153 sheets
Insects	3,500
Shells	1,500
Miscellaneous invertebrates	650
Total	23,169

As the result of this expedition, the biological collections now in the National Museum from East Africa are probably the most complete and systematic of any in the world.

THE INSTITUTE OF ARTS AND SCIENCES OF COLUMBIA UNIVERSITY

New York is to have an Institute of Arts and Sciences, which has been organized by Columbia University, to begin operation next fall. The object of the university is to offer its educational advantages to a wider constituency, including professional business men and women, and people of leisure, and to bring the general public into closer relation with its work and purposes. To this end it has been decided to offer, in the late afternoons and evenings, approximately from October to May, short series of lectures, of the university extension type, on history, literature, art, music, drama, ethics, etc., addresses by distinguished statesmen and educators from home and abroad, illustrated lectures on travel, lecture recitals on forthcoming opera, orchestral programs, the history of music, etc., dramatic readings and recitals, and occasional dramas, authors' readings, concerts and recitals by orchestras, operatic singers, and other artists, and oratorios and chorus concerts by the Columbia University Festival Chorus.

The work of the institute will be distinct from the regular academic work of the university and will not receive academic credit in any way, its aim being mainly to furnish a platform for the free and unbiased discussion of current social and economic questions, and to afford a thorough program for general culture, in other words, to provide a system of adult education and rational recreation of an educational nature for busy people. The university offers at present many miscellaneous public lectures which are provided for by special endowment or by exchange professorships, and at times the attendance has been so large that thousands have been turned away. All these lectures will be incorporated in the program of the institute. While many of these lectures and events will be held in the auditoriums on the university campus it is likely that a part of the program will be offered at a Harlem center and also at a down town center, and, as the work grows, other centers will be established. It is expected that about 300 lectures and entertainments will be offered during the season by the best lecturers and artists.

While no definite program for the first season can be announced now the institute has assurances of the cooperation of the Philharmonic Society Orchestra, the New York Symphony Society Orchestra under Walter Damrosch, the Kneisel quartet, and many other organizations, while well known soloists will probably be included in the list of entertain-

ments. The entire control of the Institute will be in the hands of Professor James C. Egbert, the Director of Extension Teaching, who will be assisted by Milton J. Davies, who was secretary to President George E. Vincent, of the Chautauquan Institution, and later was supervisor of lectures and concerts for the Brooklyn Institute of Arts and Sciences. He leaves the position of educational director of the Brooklyn Central branch of the Y. M. C. A. The fee for membership in the institute is $10 annually and the first thousand members will not have to pay a registration fee. After that the registration fee of $5 will have to be paid, once only, however. A membership ticket will admit one person to the day lectures during the entire season, and two to the night lectures. For certain of the more costly events on the program, such as special concerts, membership will be given a reduced rate of admission.

SCIENTIFIC NOTES AND NEWS

The National Academy of Sciences will hold on April 22, 23 and 24, an adjourned meeting to celebrate the semi-centennial anniversary of its foundation. The academy held its first meeting in New York on April 22, 1863. In addition to the American speakers there will be three speakers from Europe, Professor J. C. Kapteyn, of the Astronomical Laboratory of Groningen, Holland, on "The Structure of the Universe"; Professor Arthur Schuster, secretary of the Royal Society of London, on "International Cooperation in Research"; and Professor Theodor Boveri, of Würzburg, on "The Material Basis of Heredity."

The Oxford University convocation has voted to confer the degree of doctor of science on Dr. Josiah Royce, professor of the history of philosophy at Harvard University, who has been giving a course of lectures at Manchester College, Oxford.

The University of Calcutta has conferred the degree of doctor of science on Dr. A. R. Forsyth, F.R.S., who has given a course of mathematical lectures at the university.

The Helmholtz medal of the Berlin Academy of Sciences has been awarded to Professor S. Schwendener, of the Berlin University, for his researches in plant physiology.

At the annual meeting of the Royal Astronomical Society on February 14, the gold medal of the society was presented to M. Henri Delandre, of the Meudon Solar Observatory. Officers were elected as follows: *President*, Major E. H. Hills, C.M.G., F.R.S.; *Vice-presidents*, Sir W. H. M. Christie (late astronomer royal), Dr. F. W. Dyson, Mr. A. R. Hinks and Professor H. F. Newall. Mr. Knobel was reelected as treasurer. Mr. A. S. Eddington and Mr. A. Fowler were elected secretaries, and Sir David Gill was reelected to the office of foreign secretary.

At the anniversary meeting of the Geological Society of London officers for the ensuing year were appointed as follows: *President*, Dr. A. Strahan, F.R.S.; *Vice-presidents*, Professor E. J. Garwood, M.A., Mr. R. D. Oldham, F.R.S. Mr. Clement Reid, F.R.S. and Professor W. W. Watts, F.R.S.; *Secretaries*, Dr. A. Smith Woodward, F.R.S. and Mr. H. H. Thomas; *Foreign Secretary*, Sir Archibald Geikie, President R.S.; *Treasurer*, Mr. Bedford McNeill.

The Franklin Institute, Philadelphia, acting through its committee on science and the arts, recently awarded the Elliott Cresson gold medal, the highest in the gift of the institute, to the following gentlemen:

Charles Proteus Steinmetz, A.M., Ph.D., of Schenectady, New York, in recognition of successful application of analytical method to the solution of numerous problems of first practical importance in the field of electrical engineering.

Emile Berliner, of Washington, D. C., in recognition of important contributions to telephony and to the science and art of sound-reproduction.

Isham Randolph, D.Eng., of Chicago, Ill., in recognition of distinguished achievement in the field of civil engineering.

John William Strutt, Baron Rayleigh, P.C., J.P., D.C.L., LL.D., F.R.S., Hon.C.E., Sc.D., of Witham, Essex, England, in recognition of extended researches of signal importance in physical science.

Sir William Ramsay, K.C.B., LL.D., D.Sc., M.D., Ph.D., F.R.S., F.C.S., of London, England, in recognition of numerous discoveries of far-reaching importance in the science of chemistry.

Emil Fischer, Ph.D., M.D., D.Sc., F.R.S., of Berlin, Germany, in recognition of numerous contributions of fundamental importance to the science of organic and biological chemistry.

THE annual dinner of the Alumni Association of Stevens Institute of Technology, held on February 14 at the Hotel Astor, took the form of a testimonial to Dr. Humphreys on the tenth anniversary of his inauguration as president of Stevens. The regard of the alumni was evidenced by the presentation of a model of the historic Stevens Castle which was recently purchased by the institute.

DR. JAMES LAW, emeritus professor of veterinary medicine at Cornell University, was seventy-five years old on February 13. In the afternoon Acting President Crane and all the members of the faculty of the Veterinary College called upon Dr. Law at his home to congratulate him.

THE senate on February 20 voted to grant permission to Col. W. C. Gorgas of the Isthmian Canal Commission to enter the service of the Republic of Ecuador for the purpose of cleaning up the port of Guayaquil.

IT is announced that the Canadian government will grant Mr. Stefansson the sum of £15,000 towards his expedition into unexplored territory north of the Canadian mainland. Mr. Stefansson will take with him Canadian students with scientific knowledge, and the expedition will be directly under the Canadian Geological Survey. He expects to be absent three winters and four summers.

DR. H. MONMOUTH Smith, since 1902 professor of chemistry at Syracuse University, has accepted a research position in the nutrition laboratory of the Carnegie Institution.

MR. LANCASTER D. BURLING, assistant curator of the division of invertebrate paleontology in the United States National Museum, has resigned to accept the position of invertebrate paleontologist in the Geological Survey of Canada.

MR. ROBERT ANDERSON has resigned as geologist of the United States Geological Survey and will engage in professional work, in partnership with Mr. A. C. Veatch, specializing in the geology of petroleum.

MR. DAVID HOOPER, curator of the Industrial Section of the Indian Museum, Calcutta, has been appointed economic botanist to the Botanical Survey of India.

PROFESSOR BIER, of the University of Berlin, who has been quoted as having spoken favorably of Dr. Friedmann's treatment for tuberculosis, has given out a statement which concludes as follows: "I must therefore publicly protest against the misuse of my name for the recommendation of a remedy of whose effectiveness I have so far no evidence. I hope that this statement may find its way into the foreign press as quickly and as widely as my alleged recommendation of the treatment. It should also relieve me of the burden of constantly answering letters and stating that I have seen as yet no evidence of any unusual curative action of Friedmann's treatment."

A JOINT meeting of the Washington Academy of Sciences and the Philosophical Society of Washington was held on March 1, in the assembly hall of the Cosmos Club, when an address was given by the Right Honorable James Bryce on "The Physical Aspects of Australia and New Zealand."

PROFESSOR EDWIN G. CONKLIN, of Princeton University, will lecture before the Harvey Society at the New York Academy of Medicine on March 8, his subject being, "The Size of Organisms and their Constituent Parts in Relation to Longevity, Senescence and Rejuvenescence."

N. H. DARTON, geologist, Bureau of Mines, gave recently two lectures on applied geology to the advanced geological students at Columbia University. The subjects were "Construction of Structure Maps of Coal Basins" and "Construction of Maps showing Artesian Water Conditions."

PROFESSOR JOHN B. WATSON, of the Johns Hopkins University, is giving at Columbia a course of eight lectures on animal behavior.

The lectures are given on Monday and Tuesday afternoons at four o'clock.

Professor Karl Bezold, of the University of Heidelberg, is lecturing on ancient oriental art at Chicago, Princeton and other universities.

Professor J. F. Kemp, of Columbia University, lectured on the Catskill Aqueduct of New York and the application of geology to great engineering enterprises, at the Pennsylvania State College on February 25. After the lecture a banquet was tendered Dr. Kemp by the Research Club, consisting of the local members of the Sigma Xi.

The forty-fourth annual presidential address was given on February 13 by Albert McCalla, Ph.D., before the State Microscopical Society of Illinois at Chicago, the subject being "Microscopic Research as an aid to Industrial Arts and Allied Sciences."

On February 25 Professor H. H. Turner began a course of three lectures at the Royal Institution on "The Movements of the Stars"; and on Thursday, March 6, Mr. W. B. Hardy delivered the first of two lectures on "Surface Energy." The Friday evening discourse on February 28 was delivered by the Hon. R. J. Strutt on "Active Nitrogen," and on March 7 by Mr. C. T. R. Wilson on "The Photography of the Paths of Particles ejected from Atoms."

Dr. Philip Hanson Hiss, professor of bacteriology in the College of Physicians and Surgeons, Columbia University, the author of important researches on immunity and infectious diseases, died on February 27, aged forty-four years.

Charles W. Hooker, Ph.D., entomologist of the Federal Experiment Station and plant inspector of the Port of Mayaguez, Porto Rico, died on February 12, at the age of thirty, following an attack of appendicitis. Dr. Hooker, who was a graduate of Amherst College in the class of 1906, received his doctor's degree in entomology at the Massachusetts Agricultural College in 1909.

Sir William White, F.R.S., the distinguished naval architect, for many years chief constructor of the British navy, president of the British Association for the Advancement of Science for the next annual meeting, died on February 28, aged sixty-eight years.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of John Fritz, the iron master, his residuary estate amounting to about $150,000 is given to Lehigh University primarily as an endowment fund for the maintenance of the Fritz Engineering and Testing Laboratory. It is also announced that Mr. Charles L. Taylor, of Pittsburgh, has given Lehigh University a gift for a large gymnasium and a stadium.

By the will of the late Mr. C. C. Weld, of Newport, R. I., the Boston Lying-In Hospital receives $125,000, and the Boston Dispensary $100,000, while the residuary estate, valued at nearly $4,000,000, is in case the daughter of the decedent dies without issue, to be divided between the Massachusetts General Hospital and the Massachusetts Institute of Technology.

Plans for the new electrical laboratory of Harvard University, which is to be built between the Jefferson Physical Laboratory and the Peirce Hall, are nearing completion, and it is expected that actual work of construction will begin early in the spring. The building will cost about $60,000 and is an anonymous gift to the university.

Applications for the Kahn Foundation for the Foreign Travel of American Teachers should be handed to the secretary of the foundation, Sub-station 84, New York City. The next fellows will be selected by the trustees early in May and will begin their travels on July 1, 1913. The reports of the first appointees, Professor Francis Daniels, of Wabash College, and Professor J. H. T. McPherson, of the University of Georgia, are now in the printer's hands. Two fellows are at present abroad: Professor Ivan M. Linforth, of the University of California, is about to leave Germany for the Orient; and Professor William E. Kellicott, of Goucher College, is at present in the British Isles and will shortly

leave for France. The fellowships carry with them stipends of $3,000 and no obligations other than that of making a year's trip around the world and the rendering of a report thereon to the trustees.

AN anonymous donor has offered to the University of Cambridge £10,000 towards the endowment of a chair of astrophysics.

THE University of Birmingham having received an offer from the Board of Agriculture of a grant-in-aid, to be expended in carrying on a research department in agricultural zoology, has appointed Professor F. W. Gamble, F.R.S., as director of the new department.

DR. WALLACE W. ATWOOD, associate professor of physiography and general geology in the University of Chicago, has been appointed professor of physiography in Harvard University.

DISCUSSION AND CORRESPONDENCE

CYTOLOGICAL NOMENCLATURE

THE only possible use for a system of nomenclature is to secure accuracy and convenience in its application. So soon as it produces confusion and becomes unwieldy and cumbersome it defeats its purpose. The real reasons for applying a name to an object are to secure its accurate identification and to facilitate description. It is entirely secondary whether this name is descriptive or not. This fact is fully recognized among biologists in establishing the rule of priority, the sole purpose of which is to secure a definite and permanent relation between an object and its name.

Considerations of this sort apparently have no appeal to cytologists, whose nomenclature is accordingly falling into lamentable confusion. This has resulted very largely from an evident desire to make each term descriptive rather than precise. The same object, whose common identity is recognized by every observer, may, in each study, receive a different name because some real, or supposed, characteristic appeals to the describer. The final result of this practise is easily foretold and is even now making itself manifest. The beginner, instead of being able to acquaint himself with the known facts, is obliged to spend a large part of his time in untangling a complicated terminology; and, unless he has the help of some one personally familiar with the varied career of each term employed, is very apt to go astray. Much time and trouble are also expended by the initiated in discussing the relative descriptive values of the names given to the same object.

It should be the purpose of every investigator to make the machinery of his science as simple as possible and to subordinate everything to the main aim of discovery. The reasonable way to accomplish this is to profit by the experiences of workers in other and older fields and to make such applications of general principles as have been found desirable and necessary in actual practise. It is of little moment whether we are endeavoring to discriminate between two organisms or between two structural elements of these organisms—in either case it is necessary for us to designate the contrasted objects by names which apply to them alone. At the same time it very much simplifies the discussion if but a single term is used for each. Systematists have found that the only way to secure this precision is to insist that the first name applied to any kind of organism be its designation, whether descriptive or not. It seems to me that cytologists may well profit by the hard-earned experiences of the taxonomists and avoid the difficulties of an ineffective terminology. Another practise of systematists that is suggestive of simplicity is the use of qualifying prefixes to well-established words where a new term is called for in the discussion of a subgroup. I feel convinced that a recognition by cytologists of these two principles of nomenclature would do much toward reducing the confusion now existing.

There may be some who do not agree with me regarding the subordinate value of the descriptive element in terminology and who would cite the B N A system of anatomists as a support of their view that terms should be descriptive. The conditions confronting the two classes of workers are, however, entirely

different. The anatomists have a very thorough knowledge of their subject so that they may apply descriptive terms with certainty in most cases, and then, again, their major terms are well fixed by long usage and the modifications proposed in the Basle system are in most cases restricted to qualifying terms. Cytologists, on the contrary, have no such familiarity with their subject and there is lacking an agreement regarding the application of even major terms. Undoubtedly the subject of human anatomy forms the best instance of the possibility of the application of descriptive terms, but even here the necessity for their use is definitely denied and provided against by the fourth principle which reads (Barker, B. N. A.):

> The terms shall be simply memory signs, and need lay no claim to description or to speculative interpretation.

It thus appears that in two of the oldest branches of biological science, general taxonomy and human anatomy, the necessity for definiteness of application in terms, to the neglect of descriptive value, has manifested itself. It would certainly seem the part of wisdom for cytologists to avoid the difficulties which will inevitably arise through the practise now prevailing in their science by applying well-tried methods in their nomenclature.

C. E. McClung
University of Pennsylvania

A SUGGESTED CLASSIFICATION OF WRITINGS ON EUGENICS

The following note is published in response to various inquiries as to a schedule for classifying eugenical writings, for bibliographies, libraries, etc. It lends itself to the decimal system of classification, if desired.

Eugenics

0. Philosophy and bearings of; compendia, essays; periodicals, societies, institutions (record offices, laboratories, etc.), methods, history, bibliography, biography.
1. Racial anthropology.
2. Genealogy or family history, eugenic and cacogenic families.
3. Heredity, including mental traits, normal and pathological (see "Trait, Book of the Eugenics Record Office," Bulletin No. 6).
4. Differential selection of mates and its social control.
5. Differential fecundity and its social control.
6. Differential survival and its social control.
7. Migration and its social control.
8. Culture of the innate traits; relations to eugenics of education, religion, and work for social and individual welfare.

C. B. Davenport
Cold Spring Harbor, L. I.,
February 10, 1913

EQUINE PIROPLASMOSIS IN THE CANAL ZONE

To the Editor of Science: I wish to note the occurrence of equine piroplasmosis in the Canal Zone. The parasite closely resembles *Piroplasma caballi* Nuttall, 1910, and differs from *Nuttallia equi* (Laveran) in not displaying "cross forms."

Equine piroplasmosis has, so far as the literature at hand discloses, appeared in only two other localities in America—São Paulo, Brazil, and Venezuela. The infected animal was an American driving horse that had been on the isthmus several years and no doubt became infected from ticks while driven out into Las Sabanas to the Juan Diaz River. The disease is very likely epizootic in the interior of the republic, for native cattlemen speak of a disease of horses there resembling anthrax.

In view of the fact that among animals in the commission corrals, it has been found that horses, from their use on the trails, become infested with ticks, *Dermacentor nitens* chiefly, while the draft mules, from their restricted use on the roads, usually are not infested with ticks; it is interesting to note that piroplasmosis, a tick-transmitted disease, appeared in a tick-infested horse, while murrina, the trypanosomal disease of equines of Panama (fly transmitted) was confined absolutely to draft animals, tick-infested saddle horses

never, under any circumstances, becoming naturally infected.

S. T. DARLING

BOARD OF HEALTH LABORATORY,
ANCON, CANAL ZONE

A REQUEST FROM THE AMERICAN SOCIETY OF NATURALISTS

THE American Society of Naturalists does not possess a complete set of its published "Records." It has no copy of Part IV., Volume II. The secretary wishes to complete at least one set of the "Records" to be deposited with other material at the Wistar Institute.

Several complete sets may be made up if copies of the following can be obtained: Volume I., Parts II., III., IV., V., VII., VIII., IX. and XI.

Volume II., Parts I., II., IV., V., VI. and VII.

Members of the society are therefore asked to look through their papers and to write to the secretary if they can supply any of the parts desired.

BRADLEY MOORE DAVIS,
Secretary for 1913

UNIVERSITY OF PENNSYLVANIA,
PHILADELPHIA, PA.

THE FACTS ABOUT THE ACCOUNTS OF LEARNED SOCIETIES

TO THE EDITOR OF SCIENCE: The article by Professor Hart in SCIENCE for January 10 contains errors that need correction. The financial report of the American Academy of Political and Social Science for the year 1910 has been compared with the reports of the other societies for 1911, although the Academy's financial statement for 1911 was printed in May, 1912, eight months before Professor Hart's article appeared.

The apparent discrepancy between membership list and paying members is due to the fact that Professor Hart fails to take into account the 128 life members and 503 subscribers of the Academy represented mainly by libraries and other institutions not eligible to membership.

The statement is made in the article that the expenditure of the Academy, per paying member, was $6.71 for the year 1910. This calculation is not based on the true figures for membership, and suppresses the fact that $10,493.00 was received from subscriptions to publications by non-members, from sales of current numbers, from special contributions and from life-membership fees.

The number of pages published during the year 1910 is said to be 1,523 when in fact 2,034 pages were printed. The number of words published in 1910 was 1,176,650 and not 685,000, as stated in the article.

The details are as follows:

37,300 copies of *Annals* issued in 1910.
1,500 copies of *Annals* reprinted.
10,700 copies of a Child Labor supplement.
27,800 copies of four issues of supplements.
9,500 copies of reprints.

The average cost of printing per 1,000 words was $16.37, and not $32.50, but included in this cost are items not directly chargeable to the printing of the *Annals*, as will be seen by the enumeration in the report.

Such are the facts about the American Academy. Professor Hart's statements about the American Historical Association are also incorrect. The proceedings are printed and sent out at government expense, and hence it has no postage bills of this sort in its accounts. The association does not print its own magazine, but has a contract with a publishing house which issues it at a net rate to the members of the association. The receipts for advertising and subscriptions are thus not accounted for in the report of the society, nor does it contain the bills for postage and for clerical help employed by the publishing house. These net costs can not fairly be compared with the gross costs tabulated in the annual report of the American Academy.

SIMON N. PATTEN

IS THE "ACADEMIC COSTUME" WORTH WHILE?

TO THE EDITOR OF SCIENCE: I shall not attempt to answer the above question, raised by Professor Wilder in your issue of January 31. But if the question had been worded "Is

the academic costume worth paying $35 to $95 for?" I would quickly answer "No." Considering it desirable to provide myself with a doctor's gown and hood, I purchased the silk and velvet trimming by the yard, and got a dressmaker to make the gown after the pattern of one owned by a friend. As a result I have a first-class gown of the best material, and the cost was about half the regular price of a similar gown ready made.

J.

SCIENTIFIC BOOKS

Michigan Bird Life, a List of the Bird Species known to Occur in the State Together With an Outline of their Classification and an Account of the Life History of Each Species, with Special Reference to its Relation to Agriculture. With seventy-five full page plates and one hundred and fifty-two text figures. By WALTER BRADFORD BARROWS, S.B., Professor of Zoology and Physiology and Curator of the General Museum. Special Bulletin of the Department of Zoology and Physiology of the Michigan Agriculture College. Published by the Michigan Agricultural College. 1912. 8vo. Pp. xiv + 822, 70 half-tone plates and 152 text figures.

The purpose and general character of the present work are stated by the author to be to provide an authoritative list of the birds of Michigan, with such additional information respecting them as would be useful and of interest not only to the nature lover and general reader, but to students and teachers. In a work originating with and published by a State Agricultural College, it is eminently proper that special attention should be given to the economic status of the species in relation to man's interests, yet it is recognized that each has "a scientific, an esthetic, a human value, which can not be estimated in dollars and cents," and which should forever protect it "from extreme persecution, and above all from final extinction."

An introduction of nearly thirty pages deals with the physiographic and climatic features of the state, the distribution of its plant and animal life, and especially its bird life with reference to the different areas characterized by special conditions of environment, as prairies, marshes and pine and hardwood forests. The subject "how to study birds" is discussed at some length, and with intelligence and fairness, the conclusion being that field-glass records of rare species by amateurs should not be relied upon as satisfactory evidences of occurrence. Where there is any improbability of a bird being at a given time and place, the record should "rest upon an actual specimen taken at that locality and either preserved for the examination of any one interested or at least examined and identified by a competent authority before being destroyed."

Nearly ten pages are given to the subject of migration, which includes not only comment on the migratory movements of birds in Michigan, but a summary of recent progress in knowledge of bird migration, remarks on the rapidity of flight in birds, and on the disasters known to overtake birds in migration, by which thousands upon thousands lose their lives through adverse weather conditions, so that large areas become nearly depopulated of certain species. Attention is also called to recent changes in the bird life of Michigan through deforestation of large portions of the state, the draining of marshes, etc., and the consequent increase or decrease of certain species.

The main text of the work treats, in systematic sequence, of the 326 species of birds known to occur in the state, with keys to the species and higher groups, a liberal amount of biographical matter, followed by diagnoses in small type. The life histories are especially full, with often somewhat extended discussion of the economic relations of the species to agriculture, for which the author is especially fitted by his twenty-five years of study of the complex relations of birds to insects and crops as a specialist in this field, first under the United States Department of Agriculture and later at Michigan Agricultural College. A "hypothetical list" of 62 species of birds that have been attributed to Michigan by previous

authors, but whose occurrence there is doubtful, is given in an appendix, where the alleged claims of each to a place in the Michigan fauna are set forth. A bibliography of some twenty-five closely printed pages, a glossary of technical terms, a list of contributors to the work, and an index round out the volume, which will take its place among the best of the state ornithological manuals.

J. A. A.

A School Chemistry. By F. R. L. WILSON, M.A., Assistant Master at Charterhouse, and G. W. HEDLEY, M.A., Head Science Master, Military and Civil Side Cheltenham College. Oxford, H. Frowde. 1912.

This work has been prepared to supply a demand for a shorter course than the author's "Elementary Chemistry." One who has completed the work in a satisfactory manner is prepared to take the matriculation examinations for a number of English universities. The directions for work are very full and the selection and arrangement of experiments are excellent. Wherever possible the experiments are carried out quantitatively and questions and problems are introduced at the end of each chapter. The use of this book by a student should develop his powers of observation and scientific method of reasoning and give him a good insight into the fundamental principles of chemistry.

J. E. G.

Practical Chemistry for Engineering Students. By A. J. HALE, B.Sc. (London), with an introductory note by Professor R. MELDOLA. London, Longmans, Green & Co. 1912. $1.00 net.

In the introductory note attention is called to the fact that while chemistry is recognized as necessary for engineering students, owing to the short time at their disposal for this subject and the lack of appreciation of its value by the students themselves, the course in this subject must be so arranged as to give as much as possible in a short time. In order to get some training in quantitative analysis they must know some general chemistry and qualitative analysis. Although this book is intended primarily for engineering students it is possible, by the selection of certain designated experiments, to use it in connection with a course in the chemistry of building materials. The experiments in general chemistry are well selected to bring out the general principles of the subject, and the experiments are arranged in such a manner as will bring out the quantitative relations whenever possible. This is followed by a short course on qualitative analysis and work in quantitative analysis, the latter being selected to give practise in the preparation of standard solutions, gravimetric and volumetric determinations and methods of analysis of materials of special importance for the engineer, such as water analysis, determinations of the value of fuel, furnace gases, analysis of cements and alloys. While the general method here used would be approved by most chemists, the necessarily limited number of quantitative methods which can be given would no doubt lead to a wide divergence of opinion as to the ones best suited for the purpose.

J. E. G.

Review Questions and Problems in Chemistry. By M. S. H. UNGER, A.M., Head Master, St. John's School, Manlius, N. Y. Ginn & Co. 50 cents.

An excellent manual for use in reviewing classes or formulating examination questions in preparatory school work, covering as it does all the material necessary for college entrance or college board examinations.

J. E. G.

SPECIAL ARTICLES

THE TEMPERATURE COEFFICIENT OF THE COAGULATION CAUSED BY ULTRAVIOLET LIGHT

IT has been pointed out in a previous paper[1] that certain proteins coagulate when exposed to ultraviolet light. In order to learn something about the nature of this reaction it seemed desirable to investigate its temperature coefficient. As photochemical reactions in general are nearly independent of tempera-

[1] SCIENCE, N. S., 37: 24–25, 1913.

ture, it seemed possible that the speed of the coagulation might not be greatly affected by temperature.

In order to test this matter, crystallized egg albumin was prepared by the method of Hopkins and Pinkus. The albumin was recrystallized seven times; the ammonium sulfate was not dialyzed out. A 5 per cent. solution of this albumin was placed in quartz test tubes and exposed to the light from a quartz mercury vapor lamp. The temperature was controlled by keeping the quartz test tubes in water baths automatically maintained at various temperatures and so arranged as to give the tubes equal illumination. The amount of coagulation was estimated by measuring the amount of deposit in the test tubes after centrifuging in sedimentation tubes. The result of these experiments indicated that the temperature coefficient equals or exceeds two.

Of especial interest is the behavior of the tubes which were kept at 0° C. These tubes were still clear after being exposed to the light for 35 hours, while those exposed at higher temperatures contained coagulum. If the tubes which had been exposed at 0° C. were warmed a few degrees their contents began to coagulate. If they were put back into the ice water as soon as the coagulum began to appear the reaction was reversed and the tubes cleared up. This result could be obtained only by cooling the tubes to 0° C. as soon as the coagulum began to appear.

We are dealing here with at least two reactions, first, the change produced by the light, and, second, the production of a visible coagulum.[2] Only the latter has a temperature coefficient as high as two. To demonstrate this it is only necessary to expose tubes at various temperatures for a few hours, turn off the light, remove the tubes from the bath at 0° C. and place them in a warm bath. Although the tubes are perfectly clear when removed from the ice water, a coagulum appears as soon as they begin to warm up. The amount of this coagulum is about the same as if the tubes had been kept in the warm bath during the entire period of exposure to the light. It is therefore evident that the action of the light is about the same at 0° C. as at the higher temperatures. We are apparently justified in concluding that the light produces a substance which promotes coagulation and produces it about as rapidly at the lower temperature as at the higher, but that this substance is unable at 0° C. to bring about any visible coagulation, at least during the time of this experiment. Evidently the temperature coefficient of the light reaction is very low in this case, as is the rule in light reactions. The method of the experiment yielded only approximate results, since the tubes which were kept at 0° C. and which remained clear during the exposure allowed a better penetration of light than those maintained at higher temperatures in which coagulum formed. The highest temperature was only 50° C.

These experiments allow an interpretation of the results of Blackman and Matthei[3] according to whom the process of photosynthesis has a temperature coefficient as high as two. It is of course highly improbable that a photochemical reaction has a temperature coefficient which is so high. It seems much more probable that in photosynthesis, as in the coagulation above described, light acts almost independent of temperature in producing a substance which then undergoes a reaction with other substances, and that it is this latter reaction which has the high temperature coefficient.

The time-temperature curve of the coagulation of proteins by heat has been worked out with great care by Chick and Martin.[4]

[2] In the presence of certain salts some proteins in solution may be denatured by heat, but no visible coagulum forms until the salts are dialyzed out. Whether this has any relation to the phenomenon here described can not be discussed at present.

[3] "Experimental Researches on Vegetable Assimilation and Respiration. III. On the Effect of Temperature on Carbon-dioxide Assimilation," *Phil. Trans. Roy. Soc. of London*, B., 197: 47–105, 1904.

[4] "On the Heat Coagulations of Proteins," *Journal of Physiology*, 40: 404, 1910; *ibid.*, 43: 1, 1911.

In order to determine whether the character of this curve is altered by exposing the protein to ultraviolet light experiments were made with egg albumin which had been freed from ammonium sulfate by dialyzing for a long time against tap water. The albumin was exposed at 0° C.: samples were then placed in tubes and heated to various temperatures in a water bath. The tubes were centrifuged and the volume of coagulum estimated. The method gave only approximate results. However, they were consistent, and the differences in the amount of coagulum obtained under the various conditions were so great that it is evident that the temperature-time curve for coagulation, by heat, of egg albumin which has been exposed to the light, is of the same general form as the one given by Chick and Martin. But the curve lies at all points from 10° to 15° C. below the one given by them.

The chief result of these experiments is that two reactions are involved in the coagulation of proteins by light: the chemical change caused by the light, and the production of a visible coagulum. The light reaction has a very low temperature coefficient, while the reaction producing the visible coagulum has a much higher temperature coefficient. It is probable that similar relations exist in other biochemical and physiological processes which result from the action of light.

W. T. BOVIE
LABORATORY OF PLANT PHYSIOLOGY,
HARVARD UNIVERSITY

THE BOTANICAL SOCIETY OF AMERICA

THE annual meeting of the Botanical Society of America was held in the Chemical Building of Western Reserve University, Cleveland, Ohio, December 31 to January 2, 1913.

The following officers were elected for the ensuing year:

President—D. H. Campbell, Leland Stanford University.

Vice-president—M. A. Howe, New York Botanical Garden.

Treasurer—Arthur Hollick, New York Botanical Garden.

Councilor—George F. Atkinson, Cornell University.

These with R. A. Harper and William Trelease, councilors, and George T. Moore, secretary, constitute the council for 1913.

The following botanists were elected to associate membership: Robert F. Griggs, Ohio State University; Alfred P. Dachnowski, Ohio State University; Warner Jackson Morse, Maine Experiment Station; L. Lancelot Burlingame, Leland Stanford University; John J. Thornber, University of Arizona; James Theophilus Barrett, University of Illinois; Arlow Burdette Stout, New York Botanical Garden; Ezra Brainerd, Middlebury, Vt.; Norman Taylor, curator, Brooklyn Botanic Garden; William Dana Hoyt, fellow by courtesy, Johns Hopkins University; Edward M. Gilbert, University of Wisconsin; Lester Whyland Sharp, Alma, Michigan; William Skinner Cooper, Carmel, California.

A symposium on "Permeability and Osmotic Pressure" was held January 1, participated in by Professors Jacques Loeb, Harry C. Jones, W. J. V. Osterhout and Burton E. Livingston. The papers will be printed in the *Plant World*.

The address of retiring President W. G. Farlow, on "The Change from the Old to the New Botany in the United States,"[1] was delivered at the dinner for all botanists, on the evening of January 1.

Amendments to the constitution, making it possible for all those actively interested in botanical work to become eligible for membership and providing for "fellows," were adopted. The dues for 1913 were made $1.00. Active steps for the publication of a botanical journal by the society were taken.

First Generation Hybrids between Œnothera Lamarckiana and O. cruciata: GEORGE H. SHULL, Carnegie Institution.

Constant Variants of Capsella: HENRI HUS, University of Michigan.

Pedigree cultures from the original individual proved the existence of constant forms, not previously reported. Some of these apparently are not identical with the biotypes previously described by Shull. Emphasis is laid on the importance of the study of seedling stages, since, for purposes of identification, climax leaves may be relied upon under certain conditions only.

[1] SCIENCE, January 17, 1913.

The Problem of the Origin of Œnothera Lamarckiana De Vries: B. M. Davis, University of Pennsylvania.

The identification of Lamarck's evening primrose, *Œnothera Lamarckiana* Seringe 1828 (*O. grandiflora* Lamarck ?1798), as a form of *Œnothera grandiflora* Solander 1789,[2] has materially changed the situation with respect to the origin of the plant which has been the subject of such extensive experimentation by Professor De Vries. *Œnothera Lamarckiana* Seringe becomes a synonym of *O. grandiflora* Solander and the plant of De Vries's cultures is left without a name or at least without the authority of Seringe. I have proposed in the paper cited above that the name *Lamarckiana* be kept for De Vries's plant and that the name be written *Œnothera Lamarckiana* De Vries. The retention of the old name is justified by the fact that the *Lamarckiana* of De Vries's cultures is not known as a native species in any part of the world and there is good reason for believing that the plant has come down to us as a hybrid and a product of a long period of cultivation. To change the name of this plant made famous by the studies of De Vries would carry endless confusion through the literature of experimental morphology.

Œnothera Lamarckiana De Vries first appeared on the market when introduced by the firm of Carter and Company, seedsmen in London, about 1860. There is evidence from a sheet in the Gray Herbarium[3] that this plant underwent certain modifications during the twenty-five years that elapsed before De Vries began his studies upon *Lamarckiana.* The problem of the origin of *Œnothera Lamarckiana* then centers on the history and composition of the cultures of Carter and Company.

Carter and Company state that they received their seed unnamed from Texas. If this is correct we have reason to hope that thorough exploration in the south and west may bring to light large-flowered œnotheras from which *Lamarckiana* might have been derived either directly or indirectly as a hybrid. American botanists have then the problem of the discovery and isolation by culture of any large-flowered œnotheras in the south and west which might have had a direct relationship to *Lamarckiana* or which might have been one of the parents of a possible cross. The rediscovery of *Œnothera grandiflora* Solander in Alabama was a good beginning in this search, but the search should be pushed further. There is thus a tangible problem of whether or not such forms are or ever were present as native American species. If they were present in Texas in 1860 they may surely be expected there to-day.

The fact that large-flowered œnotheras were established in England as early as 1806 in localities (as the sand hills of Lancashire) which are at present occupied by extensive growths of *Lamarckiana* suggests the possibility that *Lamarckiana* was in England before 1860 and that the cultures of Carter and Company may have come not from Texas but from some part of England, and that their association with a Texan source may have been some mistake on the part of the seedsmen. English botanists have the problem of the history of such *Œnothera* floras as that of the Lancashire sand hills, and collections should be searched with great thoroughness for herbarium sheets that may be of assistance in tracing its development.

With Lamarck's plant, grown in Paris about 1796, identified as a form of *Œnothera grandiflora* Solander there has developed a much clearer situation than formerly when attempts were made to place the time of the introduction into Europe of *O. Lamarckiana* De Vries at various dates previous to 1778, the year when *O. grandiflora* Solander was introduced at Kew. There is then on historical grounds no evidence why *Lamarckiana* De Vries might not have arisen in England after 1778 as a hybrid between forms of *grandiflora* and forms of *biennis.* This is the working hypothesis which is receiving strong support from my experimental studies with hybrids between strains of *biennis* and *grandiflora.*

An exhibit of hybrids between *Œnothera biennis* and *O. grandiflora* that resemble *O. Lamarckiana* De Vries was then discussed.

The Experimental Demonstration of the Validity of the Biological Doctrine of Recapitulation: E. C. Jeffrey, Harvard University.

The Plant Formations of the Nebraska Sandhills: R. J. Pool, University of Nebraska.

The sandhills of Nebraska cover an area of approximately 20,000 square miles, which lies to the north and west of the central portion of the state. The soil of the upland is a straw-colored sand mostly of Tertiary origin. This sand has been blown into innumerable dunes which cover the

[2] See Davis, *Bull. Tor. Bot. Club,* November, 1912.

[3] See Davis, *Amer. Nat.,* XLVI., p. 417, 1912.

underlying rocks of the Arikaree formation with a loose porous soil varying in depth from a few feet to over 150 feet. Wind action is still a pronounced factor in shaping the topography of the uplands, although the region as a whole is practically stabilized by invading vegetation. The influence of wind is reflected most forcibly at present in the regions of active "blow-outs" and "sand-draws."

The greater part of the upland in this great dune region is effectively held against wind erosion by the Bunch-grass Association, a sub-division of the Prairie Grass Formation. Another conspicuous association of the upland is the Blow-out Association. The valleys are characterized by less xerophilous association which in the main are members of the Prairie Grass Formation to the east. The Short Grass Formation has pushed in from the west in a number of places and has occupied especially the hard land in some of the valleys. Forest formations are found along streams and spring branches that are related to the central hardwoods region and to the Rocky Mountain forest region. The streams, wet valleys and numerous lakes reveal the presence of a number of marsh and aquatic associations which are in the main similar to such associations found farther eastward in the Prairie Grass Formation.

The International Phytogeographic Excursion of 1911 and 1913: H. C. COWLES, University of Chicago.

In August, 1911, there was held in the British Isles under the auspices of the British Vegetation Committee the first International Phytogeographic Excursion. A dozen phytogeographers from six different countries were conducted to the places in England, Scotland and Ireland where the natural vegetation is of greatest interest. In all the places visited there were competent British guides, who were very familiar with the vegetational features to be considered. The guiding spirit of the excursion was Dr. A. G. Tansley, of Cambridge, who accompanied the party throughout the tour, and attended to numberless details.

Among the many valuable features of the British excursion were (1) the opportunity of getting intimately acquainted in a short time with the most important features of the British vegetation; (2) the opportunity to know in intimate fashion the British botanists who accompanied the party and who were met from place to place, and to know with special intimacy the foreign colleagues with whom we were associated closely every day for a month; (3) the opportunity to discuss the problems of vegetation as we met them together in the field, and thus without misunderstanding one another and with the certainty that we were talking about the same things.

It was the unanimous opinion of those who participated in the British excursion that the benefits to all were so considerable that similar excursions should be made a permanent feature of International Phytogeography, and at frequent intervals. The second excursion has been definitely announced for the United States in August and September, 1913, and it has been suggested that a third excursion be held on the continent of Europe, immediately after the conclusion of the London Botanical Congress in 1915. It is hoped that American botanists, and especially those interested in the advance of ecology and plant geography, will cooperate in every way possible to make the excursion of 1913 a great success.

Prairie Openings in a Forest Region: B. SHIMEK, Iowa State University.

A prairie opening on the exposed terminus of a ridge near Iowa City, Iowa, has retained its original prairie flora through all the changes incident to the clearing of much of the surrounding country and the building of an electric railway which cuts a part of the ridge.

The distinction between the flora of this area and an adjoining timbered tract is sharply brought out by comparative lists of the plants. The plants of the latter area are broad-leaved, and the leaves present a distinct dorsi-ventral structure, while those of the prairie are narrow-leaved, and the leaves are often more nearly erect or ascending.

A comparison of evaporation and transpiration on the two areas shows that evaporation is much greater on the open surface, but that transpiration may be less.

An artificial opening, created by a road-clearing through the original forest near Homestead, Iowa, more than fifty years ago, is similarly discussed with reference to its flora. The greater part of the area is somewhat sandy, and the road-strip, which is about fifty feet wide, extends almost due north and south through about a mile of forest.

This roadway has been kept clear of larger brush and small trees which occasionally spring up, and as a result a very characteristic prairie flora has taken possession of most of the roadside.

Both areas are discussed with reference to their bearing on the question of the causes of the treelessness of the prairies, and the fact is emphasized

that prairie fires especially could not have been the cause.

Vegetation Features of the Columbus Quadrangle: A. Dachnowski and F. B. H. Brown.

The Genus Helianthus in Southern Michigan: S. Alexander.

This paper involves the recognition of a large number of new forms. An attempt is made to classify sunflowers on the basis of their underground systems and of their venation.

The Regulatory Formation of Tannase in Aspergillus niger and Penicillium sp.: Lewis Knudson, Cornell University.

Aspergillus niger, Penicillium rugulosum and *Penicillium* sp., can ferment tannic (gallotannic) acid, gallic acid resulting. Employing the two organisms *Aspergillus niger* and *Penicillium* sp., the writer made experiments in which a modified Czapek's solution was employed as the nutrient medium. When the source of carbon is tannic acid, gallic acid or cane sugar supplemented by tannic or gallic acids at certain concentrations, these organisms form the enzyme tannase. In the absence of tannic or gallic acids no tannase is formed. In these experiments the effect of each of fourteen other organic compounds was tested, but none could stimulate the formation of the tannase. The gallic acid is not as efficient as the tannic acid in stimulating to formation by these organisms the enzyme tannase.

In certain experiments the influence of concentration of tannic acid on the quantity of the tannase produced was determined. The source of carbon was 10 per cent. sugar supplemented by tannic acid in variable quantities. It was found that the greater the concentration of tannic acid present the greater is the quantity of the enzyme tannase produced. The greatest quantity of enzyme is produced when tannic acid is the sole source of carbon. In other experiments the source of carbon was 2 per cent. tannic acid, and variable quantities of cane sugar employed. It was found that the higher the concentration of cane sugar the less is the quantity of tannase produced.

The Relation of Ventilation to the Respiration of Fruits: George R. Hill, Jr., Missouri Botanical Garden.

A study was made of the respiration and other metabolic phenomena of green and well-ripened fruits which had been placed in nitrogen, hydrogen air and carbon dioxide. Cherries, blackberries, green, market-ripe and very ripe peaches, ripe red Astrachan apples and Concord and Catawba grapes were used. Particular attention was given to an investigation of the common cold storage injury to peaches, "ice-scald," and the results point quite definitely to a close relationship between it and anaerobic respiration. The keeping qualities of the fruits in storage in the gases named, and the relation of these to ventilation, was also considered. The experiments were run in triplicate and the temperature was kept constant by an apparatus devised especially for the purpose.

Conditions Affecting the Development of Lycopin in the Tomato: B. M. Duggar, Missouri Botanical Garden.

Willstätter and Escher have shown that the red pigment of the tomato (lycopin, solanorubin) and carotin (derived from the carrot) are isomeric compounds, readily distinguishable by their physical properties. In the ripening tomato both lycopin and carotin occur. An experimental study of the effects of various conditions upon ripening demonstrates that while carotin is developed under conditions of growth differing widely, lycopin is formed only within a limited range of metabolic activity. Temperature and oxygen supply are two of the factors indirectly limiting lycopin development. In yellow varieties of the tomato "carotin" only is found, and in red varieties lycopin formation is precluded by high temperature, yellow fruits resulting. Irreversible effects are not produced by heat. Red tomatoes seem to contain a factor for redness superimposed upon the factor or factors for yellow, and this conclusion is borne out by breeding experiments.

A Chemical and Physiological Study of After-ripening of the Rosaceæ: Sophia Eckerson.

The Hawthorn is one of the few seeds where there is known to be a dormancy of the embryo. A period of "after-ripening" is necessary before germination is possible. Food is stored in the embryo as a fatty oil. Neither starch nor sugar is present. The reaction of the cotyledons is acid, but the hypocotyl is slightly basic. The water-absorbing power of the hypocotyl is less than 25 per cent. of the wet weight.

There is a series of metabolic changes in the embryo during the period of after-ripening. The initial change seems to be an increased acidity. Correlated with this is an increased water-holding power, and an increase in the activity of catalase and peroxidase. Near the end of the period of after-ripening there is a sudden greater increase in the acidity, and in the water content. All of

these increase until the hypocotyl is 3–5 cm. long. At this time the fats decrease and sugar appears.

The after-ripening period can be shortened greatly by treating the embryos with dilute solutions of HCl, butyric and acetic acids. The water-holding power, the acidity and the activity of peroxidase increase much more rapidly than in the untreated embryos.

The Use of Celloidin Membranes for Demonstration of Osmosis: G. M. SMITH, University of Wisconsin.

The membranes were prepared by pouring a 10 per cent. solution of celloidin on a dish of clean mercury and, after allowing the celloidin to dry sufficiently to be lifted, it was placed over the end of a thistle tube, tied down and allowed to harden. Two membranes were made, one over the other; the double membranes proving themselves ten times as strong as the single ones. The tensile strength of the membrane was found by setting up the osmometer and pouring in mercury and noting the height of the column, when the rupture of the membrane occurred. The double membranes stand over three atmospheres pressure without breaking.

The membranes were rendered semipermeable by putting a M/20 potassium ferrocyanide solution inside of the osmometer and immersing the apparatus in a M/20 copper sulphate solution. A good membrane is formed within the celloidin in three days. When a celloidin membrane separates water and a 3M cane sugar solution the liquid in the osmometer will rise about seven feet in three days and then sink; but when the celloidin membrane contains a copper ferrocyanide precipitate the liquid will rise about twenty-five feet in ten days and then slowly sink.

Studies of Osmotic Pressure: M. A. BRANNON, University of Chicago.

This report is based upon studies made in the plant physiological laboratories at the University of Chicago. The work extended over a period of ten months. The measurements of osmotic pressure were made by cryoscopic methods, the Beckmann apparatus being employed to determine the freezing points of the solutions used.

Three different kinds of potatoes were chosen. They were placed in controlled conditions so that only one limiting factor, heat, was involved in the experiments. One collection of potatoes was placed in an icebox where a temperature of 2° C. was maintained and one collection was kept at a temperature of 25° C.

At the beginning of the experiments the osmotic pressure of the different potatoes was about 7 atmospheres. After ten months the icebox potatoes had developed a maximum osmotic pressure of 13 atmospheres. The lower temperature favored metabolic activities resulting in the liberation of an acid, a catalyte and the fermentation of foods, stored in the form of starch and hemicellulose. The change from colloids to crystalloids was accompanied by the rise in osmotic pressure noted.

The fermentation of the hemicellulose was indicated microscopically by the great reduction in the thickness in the cell walls of the potato tissue affected, and also by the great increase in the brittleness of the potato tissues involved.

These studies are suggestive of the changes taking place in the after ripening of seeds, tubers and bulbs, and has a definite relation to several economic and scientific problems.

Protoplasmic Contractions Resembling Plasmolysis which are caused by Pure Distilled Water: W. J. V. OSTERHOUT, Harvard University.

True plasmolysis can be produced only by solutions which are hypertonic, but appearances almost or quite undistinguishable from it may be brought about by hypotonic solutions. Some light is thrown on the nature of this result by a study of certain cases in which it is caused by pure distilled water. Material for such study is afforded by marine plants.

The root tips of the eel grass (*Zostera marina*) are well adapted to this purpose. The root tips were carefully removed from the sand in which they were growing and immediately placed in sea water.

The application of distilled water causes a contraction of the protoplasm which often closely resembles the true plasmolysis produced by hypertonic sea water (which has been concentrated by evaporation) or by hypertonic sugar solutions. The mode and the degree of contraction vary somewhat, but in general the variations in true plasmolysis are of the same sort, as in what may be conveniently called the false plasmolysis. We may use the term false plasmolysis to designate not only the contraction produced by distilled water, but also that which is caused by certain hypotonic solutions.

The Effect of Anesthetics on Permeability: W. J. V. OSTERHOUT, Harvard University.

Experiments were performed to test the elec-

trical conductivity of living tissues in various solutions. The results show conclusively that a great variety of ions readily penetrate living cells and that this penetration may be markedly hindered or accelerated by the addition of various substances to the solution. The addition of anesthetics, such as ether and chloroform, has a retarding effect on the penetration. It would seem, therefore, that these substances should retard all physiological processes which depend on the transport of ions through living tissues.

Plants which Require Sodium: W. J. V. Osterhout, Harvard University.

It is generally believed that plants do not require sodium, although it is indispensable for animals. Our increasing knowledge of the biological rôle of salts makes it clear that such a distinction between plants and animals is of fundamental importance, provided it be true in all cases. But if exceptions to it be found its significance largely disappears. I have therefore undertaken to ascertain whether or not there are plants which require sodium and have begun by examining some marine plants. The results are as follows:

The marine plants studied require sodium; its replacement in sea water by NH_4, Ca, Mg, K, Ba, Sr, Cs, Rb or Li is very injurious.

The best substitutes for Na are the other salts of the sea water, Mg, Ca and K.

The diversity in behavior of various species toward the salts which were used to replace the sodium shows that each of these salts has a specific rôle in life processes.

Studies of the Wild Oat: W. M. Atwood, University of Chicago.

Avena fatua (L.) has become a pest agriculturally in the small grain regions of the north and west. In studying its germinative qualities we have found it to possess high vitality. This differs from the deductions which might be drawn from the results of other workers who have tested the seed after periods of burial in the ground.

Avena fatua germinates poorly after harvest, but the per cent. of germination increases steadily up to the succeeding spring and summer.

The early delay of germination appears to be due neither to the chemical condition of the embryo nor to coat obstructions to water entry. Oxygen seems to be the limiting factor to germination which can be forced by breaking the coats or increasing the oxygen pressure.

Investigations are now under way to determine whether the so-called "after-ripening" of the seed is due to alterations in the oxygen demands of the embryo or to increased permeability of the coat to oxygen.

Toxicity of Smoke: Lee J. Knight and William Crocker, University of Chicago.

Molisch has found tobacco smoke extremely toxic to plants of various kinds ranging from bacteria to the highest angiosperms. He finds this toxicity is not due to volatilized nicotine, for cellulose paper smoke is as toxic, but believes it is due to CO.

In the burning of organic compounds the destructive distillation carbon-bearing gases, CO, C_2H_2, C_2H_4 and CH_4 are not generally completely burned and may be the source of injury in the smoke. Exact experiments on the delicate sweet-pea seedling, Early Cromer, shows that smoke from cigarettes, cigars and cellulose paper cigarettes does not contain sufficient CO, C_2H_2 or CH_4 to determine 1/200 the toxicity of the smoke. This leaves C_2H_4, which we have already shown as extremely toxic to plants, as the substance probably determining the toxicity. The injury from smoke in our cities has been attributed to SO_2 and SO_3, so far as gases are concerned. The possible effect of the dry distillation of carbon-bearing gases has been entirely neglected. They are produced in small amounts in the burning of coal. This coupled with their extreme toxicity (especially ethylene) makes them probable factors in the smoke question.

A Delicate Test Seedling: William Crocker, Lee J. Knight and R. Catlin Rose, University of Chicago.

We have already published on the characteristic response that the etiolate of sweet pea seedlings give to ethylene. It has been termed a triple response, since it is marked by reduction in rate of elongation, increased growth in diameter and diageotropism. We have since studied the effect of more than fifty gases and vapors upon the seedling, including the paint solvents, the possible impurities of laboratory air, the main constituents of illuminating gas and the principal distillation products of coal tar. The seedlings are apparently reliable and extremely delicate in testing for ethylene—2,000 to 5,000 times as delicate as gas analysis methods. While a few other gases and vapors, carbon monoxide, acetylene, benzene, toluene, xylene, thiophene, cumene and others give the triple response they must be present in such quantities as to be easily detected by other means or they are excluded through impossibility of their

presence in the gas studied. We believe the response of this seedling furnishes a very delicate means of detecting the presence of "heavy hydrocarbons" in laboratory and greenhouse air, in smoke of all sorts and in furnace gases.

The Heat of Absorption of Water in Wood: FREDERICK DUNLAP, U. S. Department of Agriculture.

The heat evolved when water wets dry wood has been studied with the Bunsen ice calorimeter. Oven-dry wood was used; this was sealed in glass to prevent premature wetting. The wood and water were both cooled to 0° C. and brought together at this temperature and the heat evolved was measured. This is large enough to raise the dry wood entering into the reaction from 0° to about 50° C. Under the assumption that the specific heat of wet wood is the sum of the specific heats of the wood and water present in wet wood, its temperature would be raised to about 30° C.

The substance of wood as distinct from the cavities of the cell lumina is saturated when it has imbibed about 25 per cent. of its weight of water. The first per cent. imbibed produces a relatively great evolution of heat; the twenty-fifth, a relatively small evolution of heat, the curve connecting the two being convex upward.

Wood is hygroscopic and its moisture content varies with that of the atmosphere about it. The "working" of wood is due to changes of volume of its substance with changing moisture content. Measures to prevent this "working" aim either to remove the wood from the action of the atmosphere or to render it insensitive to changes in the atmosphere by destroying its hygroscopicity, at least in part. Experiments whose aim it is to destroy the hygroscopicity of wood are now in progress in the Forest Products Laboratory, and this method will be used in studying the changes produced.

Artificial Parthenogenesis in Fucus: J. B. OVERTON, University of Wisconsin.

The occurrence of natural parthenogenesis has been reported for several species among the Phæophyceæ. It is evident that this group shows a strong tendency to develop without fertilization and that natural parthenogenesis may play an important part in the life history of several species. Although Thuret mentions that unfertilized eggs of *Fucus* kept for several days become pear-shaped and that a cellulose wall is sometimes present, none of the Fucaceæ have been described as being able to develop without fertilization.

While working at the Marine Biological Laboratory the past summer, the well-known experimental methods of certain animal physiologists, whereby unfertilized eggs of certain animals have been made to develop under the influence of artificial physical and chemical stimuli, were applied to *Fucus* eggs. In plants used for experiment care was taken to prevent contamination by sperms. That female plants may be made perfectly sterile by washing in fresh water is shown by the fact that none of the eggs of such sterilized plants ever developed in the numerous controls which were run in connection with the experiments. In experimenting, the eggs used at any one time were divided into three lots. One lot was used as a control, another was fertilized and the third was placed for one third minute in a mixture of 50 c.c. of sea-water + 3 c.c. 0.1 *m* acetic or butyric acid. A large number of the eggs treated with these solutions become invested with a cell-wall in about 10 minutes. This wall is exactly similar to the one formed about normally fertilized eggs. The wall is readily seen by plasmolyzing the eggs. After the formation of the membranes, if the eggs are transferred to hypertonic sea-water for 30 minutes and then are brought back into normal sea-water, development continues. Such eggs become pear-shaped, showing a rhizoidal papilla, and by next day have cleaved. If the cultures are kept properly aerated, sporelings of about 25 cells develop in the laboratory, resembling in every respect those grown from fertilized eggs.

It would appear that the action of the acid in inducing cell-wall formation about unfertilized *Fucus* eggs is similar to the action which calls forth membrane formation in the animal egg. Considerable evidence exists indicating that the essential condition for the formation of the fertilization membrane in such eggs is an increased permeability of the plasma membrane to substances which harden in contact with sea-water. That the first effect of the sperm upon *Fucus* eggs is to cause cell-wall formation is apparent from the observations of several investigators.

No attempt was made to grow the sporelings under natural conditions. The methods used by Hoyt and Lewis are suggestive and it seems probable that the sporelings produced parthenogenetically could be grown to sexual maturity, so that the nuclear behavior during oogenesis and spermatogenesis might be investigated.

The Periodicity of Algæ: E. N. TRANSEAU, Illinois State Normal School.

The preliminary observations on algal periodicity given in this paper are based upon a study of eighteen hundred collections made at many stations in eastern Illinois during the past five years. The general richness of the waters of this region may be judged by the fact that the genus *Œdogonium* is represented by more than forty-five species and *Spirogyra* by thirty-five. Field observations indicate that sexual reproduction in nature is induced by a more definite combination of environmental factors than asexual, since the former is usually restricted to a short period of time, while the latter may occur at intervals or continuously throughout the vegetative period of the algæ.

On the basis of the time of greatest frequency, duration of the vegetative cycle and time of reproduction, algæ may be classified as follows:

1. *Spring Annuals.*—Forms whose vegetative period begins in late autumn, reaches its maximum in April and May and is followed by a decline in June. Fruiting occurs in April, May and June.

2. *Summer Annuals.*—Vegetative period begins in spring, culminates in July and August, followed by decline in autumn. Fruiting occurs in July, August and September.

3. *Autumn Annuals.*—Vegetative period begins in spring and early summer, culminates in autumn, decline comes with the beginning of freezing temperatures. Fruiting occurs in October and November.

4. *Winter Annuals.*—Vegetative period begins in autumn, continues through the winter under the ice and culminates in early spring. Fruiting occurs from November to April.

5. *Ephemerals.*—Forms having a vegetative period of a few weeks or days. Fruiting occurs at intervals during all but the winter months.

6. *Perennials.*—Vegetative period continuous with irregularly distributed maxima. Reproduction takes place during the spring, summer and autumn.

7. *Irregulars.*—Forms in which the combinations of conditions necessary for good vegetative development and reproduction occur at irregular intervals, usually of more than a year's duration.

Algæ fruit most abundantly during periods of high water following favorable conditions for vegetative development, rather than during periods of "concentration of the water," "drying up of the ponds," or the coming of "hard conditions." The drying up of pools may coincide with the fruiting of many vernal species, but it results in decreasing the number of spores formed and the number of species that fruit.

The time of fruiting of many algæ is dependent upon combinations of environmental factors rather than on "hereditary rhythm."

A more complete account of these observations will be found in the *Transactions of the American Microscopical Society,* Vol. 32, No. 1, 1913.

On the Presence of Diastase in certain Red Algæ: E. T. BARTHOLOMEW, University of Wisconsin.

In the *Florideæ,* starch granules are deposited outside the chromatophores. The granules do not usually give the characteristic reaction when subjected to iodine or zinc chloriodide, but instead turn brown to wine-red. To determine whether or not a diastase is present which will act in the ordinary way on the starch of green plants, extractions were made from the following: *Polysiphonia variegata, Ceramium* sp., *Dasya elegans* and *Agardhiella tenera.* A cornstarch paste was treated with various concentrations of these extracts, and after given periods of time tested with Fehling's solution and with iodine. The results showed that although starch digestion was much slower in the tubes treated with the algal extract than in those treated with common commercial diastase, yet the digestion went on and in time was complete; usually taking from six to nine days. In the tubes treated with the algal extract the iodine color-reactions showed that probably a series of dextrins was formed before the starch was completely digested. No doubt the great viscosity of the algal extract materially retarded its action on the paste. By running a series of controls, careful check was kept on each set of experiments. It appears, therefore, that there is present in the *Florideæ* a diastase similar to that found in green plants.

Cytological Studies on Sphæroplea: E. M. GILBERT, University of Wisconsin.

Investigation has shown that many statements made by Klebahn and Golenkin with regard to *Sphæroplea* are inaccurate.

No conspicuous pit-like depressions have been found in partition walls as described by Golenkin.

Cleavage, in the formation of eggs, begins with constrictions from the plasma membrane, and cuts the cell contents into masses of varying sizes. All stages, from those having a single row of large eggs to those having a double row of small eggs may be found in one filament, indicating the possi-

bility that Klebahn saw stages in a single form and not two distinct varieties. I have been unable to find a fusion of many nuclei in the egg as described by Golenkin, nor a multinucleated egg as described by Klebahn.

All nuclear divisions are mitotic, not simply the earlier divisions as noted by Golenkin. There is no fragmentation of the nucleolus to form the chromosomes.

Fertilization does not take place until the egg is fully formed and rounded up; at this time the egg nucleus lies in the center of the egg.

The pyrenoids vary greatly as to size and shape, and the starch is often found to be very irregularly arranged around the central structure.

A Comparison of Plant and Animal Spermatogenesis: Charles E. Allen, University of Wisconsin.

The development of the androcyte of *Polytrichum juniperinum* into the antherozoid is in several respects closely parallel to the corresponding metamorphosis of the spermatid in certain animals, notably in mammals. For present purposes comparison will be made with the spermatogenesis of the guinea-pig, well known through the researches of Meves.

1. In both spermatid and androcyte the nucleus is at first central, then comes to lie at the extreme side or end of the cell. It undergoes a great diminution in volume, its contents becoming denser and finally homogeneous. The nucleus of the spermatid is finally flattened and curved into the form of the bowl of a spoon; that of the androcyte is drawn out into a long spiral filament.

2. The spermatid possesses two *central bodies;* the androcyte contains the blepharoplast, whose centrosomic nature is a disputed question. From one of the central bodies a contractile filament grows out which becomes the axial filament of the vibratory *tail.* From the blepharoplast grow out two cilia. Out of the central bodies is developed the *end knob* or *middle piece* of the spermatozoon; the blepharoplast forms the anterior end of the antherozoid; in each case the part of the male cell in question is that to which the motile apparatus is attached.

3. The *sphere* or *idiozome* of the spermatid divides into two portions; one, the *acrosome,* forms the anterior end of the spermatozoon; the other, a spherical mass, passes to the posterior part of the cell and is finally discarded with other unused portions of the cytoplasm. The young androcyte contains a spherical body which, like the idiozome, divides into two; one lies close to the anterior end of the blepharoplast, and perhaps persists in the mature antherozoid as a delicate sheath about the blepharoplast; the other, which has been called by Ikeno (incorrectly) the *chromatoid Nebenkörper* and by M. Wilson the *limosphere,* places itself in contact with the posterior end of the elongating nucleus and is discarded with the remaining cytoplasm after the antherozoid becomes free.

4. The androcyte contains a small spherical body which seems to persist but a short time and has no discoverable function; it may be compared with the *chromatoid Nebenkörper* or with the *Nebenkern* of the spermatid, both of which are conspicuous, but temporary and apparently functionless.

5. That part of the cytoplasm in both spermatid and androcyte which is not used in forming the mature cell rounds up into a vesicle; this cytoplasmic residue is discarded by the spermatozoon before maturity, and by the antherozoid after its escape from the antherid.

How far the similarities noted are due to a series of homologies, and how far to the fact that a similar problem is to be worked out by two cells similar but of widely divergent origin, must be left for the present an open question.

Intermingling of Perennial Sporophytic and Gametophytic Generations in Rusts: E. W. Olive, Brooklyn Botanic Garden.

The Individuality of Chromosomes in the Somatic Cells of Gentiana procera: R. H. Denniston, University of Wisconsin.

The nuclei in the cells of the nucellus and integument were the ones especially studied.

The material is favorable, because the chromatin appears in the resting stages in deeply stained, well-defined masses.

In this plant there is a large number of chromosomes, about eighty. These appear closely massed together in the equatorial plate stage.

In the metaphase the chromosomes are pulled away from each other toward their respective poles. In this view the chromosomes appear as short curved rods.

The chromosomes do not lose their identity in the diaster stage, as here and there an individual can be plainly seen projecting from the mass.

The long axes of the individual chromosomes conform in general direction with the long axis of the spindle.

After the closely packed condition of the chromosomes in the diaster, they move apart somewhat,

each group appearing to occupy more space. At this time no apparent change in the density or size of individuals has taken place, but their axes now lie in many directions. The nuclear membrane appears and the nucleus has the form of an oval with the shorter diameter in the direction of the spindle. It may be that the spreading apart of the chromosomes is for the purpose of facilitating their growth, as they now appear somewhat larger. Probably the chromosomes do not grow, but become less dense, since they do not stain so intensely at this time. The nucleoles make their appearance as small oval bodies, from one to four in number. These usually combine later, to form a single nucleole.

The chromosomes now appear to become angular and to lose their curved form. Threads of linin appear and portions of the chromatin appear to be drawn out along these threads. No continuous spirem is formed, however. The chromosomes now come together in groups, forming various-sized homogeneous, angular masses. This is the condition in which the chromatin is found in the greater number of so-called resting cells in the Gentian. There are also present small particles of chromatin material along the linin threads which connect the larger masses. There is no uniformity in the number of the larger masses, and in this plant there is no indication of prochromosomes, *i. e.*, there is no relation between the number of chromosomes and the number of these masses.

Each mass appears to be composed of smaller fairly distinct bodies, but these smaller bodies do not represent the chromosomes, since they are much more numerous and vary in size. These small bodies later become arranged along the linin thread, forming a spirem.

The spirem increases rapidly in diameter, takes a homogeneous stain, and occupies a peripheral position in the nucleus. Irregularities on the surface of the spirem suggest the position of the chromatin bodies of which it was made up. Segmentation of the spirem follows and the chromosomes are formed.

These are long at first, but soon shorten to rodlike bodies, three or four times as long as broad. They are distributed throughout the nucleus and pairing does not appear to take place.

The main points in the history of the chromatin in the somatic cells of this plant are:

1. The aggregation of chromosomes in the diaster, from which, later, the chromosomes separate out.

2. The absence of a dispirem.

3. The presence in the resting nucleus of chromatin masses which vary in size and shape.

4. The breaking up of these chromatin masses into smaller fragments, more numerous than the chromosomes.

Physiological and Economic Significance of the Structure of the Tracheids of Conifers: I. W. Bailey, Harvard University.

The so-called striated tracheids of conifers are a specialized type of tissue structurally organized to resist compression. Gothan's hypothesis that "spiralstreifung" are spiral cracks confined to heartwood, and are produced by chemical changes and mechanical stresses in the transformation of alburnum into duramen, is not substantiated by a study of the origin and distribution of striations in the various coniferous genera.

Cracking or slitting of tracheid walls in drying occurs sporadically and is confined to the so-called summerwood. Tiemann in his "slit" theory of the penetration of gases and preservatives into seasoned wood has not taken into consideration the important fact that drying-cracks do not rupture the middle lamella and are confined to the secondary and tertiary walls. Injection experiments show that the membranes of bordered pits in freshly cut green sapwood are perforated and permeable to gases, colloids and finely divided solids held in suspension.

The Leaf Trace and Pitting of the Araucarineæ and their Relation with those of the Cordaitalean Forms: R. B. Thompson, University of Toronto.

The venation of the Araucarian and Cordaitalean leaves is typically dichotomous, though in some of the modern forms a false trichotomy has been acquired. In both groups the dichotomous condition persists in the secondary wood, *double traces* extending to the pith in many instances. The bundles of the double trace are far apart in the seedling of *Agathis*. Ginkgo has been up to the present the classical example of the double trace in the secondary wood for comparison with the Cordaitalean forms. The double trace in the *cortex* of the Abietineæ has been considered a vestige of this condition.

In pitting, the cone and root of the Araucarineæ show a more accentuated Cordaitalean character than that of the stem. The ordinary tracheids of the cone, for example, may have the pits as much as 5-seriate and extending from end to end of the tracheid. The ray-pitting of the tracheids retains

the multi-seriate condition longer than the adjacent part, where tracheid is in contact with tracheid. This is a contrast to some of the Abietineæ where the ray pitting consists of "Grosseiporen" derived from the fusion of smaller pits.

Both leaf traces and pitting are considered as indicating the Cordaitalean connection of the Araucarineæ and as directly opposed to the derivation of the Araucarineæ from the Abietineæ. The anatomical evidence is thus in accord with the geological, since, as has been recently shown, the forms of the older strata which were thought to have been Abietinean have proved not to be authentic.

Macrozamia Moorei, a Connecting Link between Living and Fossil Cycads: C. J. CHAMBERLAIN, University of Chicago.

A Possible Means of Identifying the Sex of + and — Strains in the Mucors: A. F. BLAKESLEE, Carnegie Institution.

Certain of the hermaphroditic species of the mucors are distinctly heterogamic, forming regularly large female gametes and smaller male gametes. By growing the (+) and (—) races of an isogamous diœcious species in contrast with such an heterogamic hermaphroditic species, a sexual reaction has been found to occur between female branches of the hermaphrodite and branches of the (—) race, on the one hand, and between male branches of the hermaphrodite and branches of the (+) race on the other hand. This reaction would lead one to consider the (—) race male and the (+) race female.

A Suggestion as to the Phylogeny of the Ascomycetes: ERNST A. BESSEY, Michigan Agricultural College.

Of the two suggested points of origin of the Ascomycetes, the Phycomycetes are excluded in view of their non-septate plant body and the simplicity of the structures resulting from the sexual union. Many of the red seaweeds, on the other hand, have a plant body in many respects similar to that of the Ascomycetes, *i. e.*, septate with a single rather large pit or pore in the septum, the segments being in both groups either uni- or plurinucleate. In both groups, the result of the sexual union is a "spore fruit," *i. e.*, a more or less extensive mass of branches from the female cell terminating in the reproductive cells. The fact that a number of red seaweeds are known which lack chlorophyll and are strictly parasitic upon other algæ (red seaweeds), very often surrounding and separating the cells of the host in a manner similar to that shown by the lichens with reference to their hosts and the fact that in the reproduction of the latter group, *e. g.*, *Collema*, the male elements are, as in the red seaweeds, non-motile sperm cells, suggests that lichens may represent a group derived from some of the more primitive red seaweeds, probably inhabitants of fresh water, that became parasitic upon colonies of Nostoc or other algæ and gradually assumed the terrestrial habit. The apothecium would correspond to the cystocarp and the ascus would phylogenetically have some relation to the carpospore. From such lichens have been derived then the non-lichen Discomycetes, on the one hand, and perhaps through the closing and becoming more firm of the apothecium, may have arisen the Pyrenomycetes. Similarly the teliospores of the rusts and smuts would be homologous to the carpospore.

Morphogenesis in Pediastrum: R. A. HARPER, Columbia University.

In the genus *Pediastrum* we find all degrees of variation in cell differentiation from species in which the colonies are composed of cells which are practically all alike to others in which only the peripheral cells are provided with well-developed spines, while in the central region the spinous projections are only slightly indicated by the kidney-shaped form of the cells with the reentering angle on the outer side. In the species with uniform cells these may show either very long spinous processes or almost none at all. The reproduction of the colonies by motile zoospores, which after swarming for from five to fifteen minutes arrange themselves spontaneously in the plate-shaped new colony shows that as in *Hydrodictyan* the form of the colony is not predetermined by any spatially differentiated representation of the adult in the organization of the germ plasm. The cells arrange themselves in accordance with the principle of least surfaces modified by their specifically inherited cell form and the law of reproduction by bipartition. All the cells of a given species are in general alike in their inherited form and capacities for differentiated growth, and are totipotent. The differentiation between cells in species which show it is due to cellular interaction in the formation and growth of the colony. This morphogenetic equivalence of the cells is most clearly shown in cases in which the cells are abnormally or unusually situated as a result of unfavorable environmental conditions. All the species share an inherited tendency to produce one or two spines

on one side of the cell. The degree to which these spines are developed in a given colony is determined by cellular interactions. The degree to which the tendency is present in different species is the basis for the delimitation of species in the genus. All the cells show also a polar differentiation, the spines being produced in the direction of the shorter of the two major axes of the cell. There is some evidence also of specifically oriented attractions between the cells such that the spines in normal individuals come to point radially outward in the interior as well as in the peripheral cells of the colony. Specifically inherited cell form and cellular interactions during growth are the principal morphogenetic factors in the development of the differentiated cell colonies of *Pediastrum.*

Tetradesmus, a New Four-celled Cœnobic Alga: G. M. SMITH, University of Wisconsin.

Tetradesmus resembles *Scenedesmus* in the number and shape of the cells, but differs from it in the cellular arrangement, the cells being in two planes, each plane containing two cells.

The reproduction is by autocolonies. The first cleavage of the mother cell is transverse and the second is in the same plane and diagonal to the line of the first cleavage. After the four daughter cells have been formed by cleavage they elongate, while still within the mother cell, taking the same relative position that they have in the mature colony. The young colony is liberated by a longitudinal rupture of the mother cell wall.

The mature cell possesses a nucleus and a pyrenoid. The nucleus divides once before the first cleavage takes place, but the pyrenoid does not. When the four daughter cells have been formed, the old pyrenoid of the mother cell is found in one of them while the other three contain no pyrenoid. This pyrenoid then disappears and pyrenoids are formed *de novo* at the time that the daughter cells are elongating prior to their liberation from the old mother cell wall.

The Relation of the Lichen to its Algal Host: BRUCE FINK, Miami University.

The common algal hosts of lichens; finding the algal hosts growing near lichens in nature; cultures of lichens from spores and spermatia with and without the algal hosts; cultures of the algal hosts separately; growth of lichen hosts and other algæ on media with and without light and carbon dioxide; breathing pores and other means of aeration of the algal hosts in lichens; lichens as carriers of food to the algal hosts; hypotheses regarding the relationship of the lichen and its algal host, with evidence from recent research.

A Dry Rot of the Irish Potato Tuber: E. M. WILCOX, University of Nebraska.

In 1908 our attention was called to the fact that potatoes grown in western Nebraska were often seriously injured by a form of rot during storage. Comprehensive investigations were undertaken to learn the exact cause and nature of this disease. It was found to be due to a new species of *Fusarium,* shortly to be published as *Fusarium tuberivorum* Wilcox and Link. Numerous inoculation experiments have established the causal relation of this organism to this tuber dry rot. The organism is, however, unable to invade any other part of the plant than the tuber, and the tuber only when it is practically mature.

The Propagation of Medicinal Plants: F. A. MILLER.

An Optimum Culture Medium for a Soil Fungus: J. B. POLLOCK, University of Michigan.

The work was done in collaboration with Miss Rose M. Taylor, and had for its object the determination of an optimum culture medium of exactly known composition and of simple constitution. The fungus chosen was one isolated from the soil by H. N. Goddard, and determined as a new species of Myceliophthora, to be described by him elsewhere under the name of *Myceliophthora sulphurea.* The medium aimed at was one with the fewest and simplest compounds which would furnish the chemical elements necessary for the growth of fungi. It is known that fungi will grow with as few as eight of the known elements, namely, carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium and magnesium. In the experiments sixteen organic compounds were tested as to their availability for carbon, and incidentally they could also supply hydrogen and oxygen. These carbon compounds were saccharose, dextrose, maltose, inulin, lævulose, arabinose, mannite, cellulose, resin, starch, glycocoll, alanin, asparagin, glycerine, potassium tartrate and sodium benzoate. The compounds tested as to their availability for nitrogen were ammonium sulphate, ammonium nitrate, sodium nitrate, potassium nitrate and calcium nitrate. In all the cultures magnesium sulphate was used to supply magnesium and sulphur. This was used in only one concentration, 1/1000 that of a gram-molecular solution = 1/1000 M. Mono-potassium phosphate was used to furnish phosphorus and potassium, and it was used in several concentrations, 1/10,

1/25, 1/50 and 1/100 M. Nitrogen compounds were used in concentrations of 1/5, 1/25, 1/125, 1/250 and 1/500 M. Preliminary experiments soon showed that this fungus could not obtain carbon from several of the compounds tried and that others had only slight availability. Only maltose, saccharose and dextrose were tried out for final results, in concentrations of 1, 2/5, 1/5, 1/10, 1/25, 1/125, 1/250, 1/500, 1/625 M.

Twenty-four sets of cultures were carried through, the number of flasks in a set ranging from six to forty-eight. The test applied for the optimum medium was the amount of vegetative growth, estimated by the eye alone in the early stages of growth for all the cultures, but in cases where the results were doubtful and also for the purpose of getting quantitative results for some of the work, in several sets the growth was determined by weight.

Conclusions.—Of the nitrogen compounds tried calcium nitrate was the best. Its best concentration was 1/250 M. 1/125 and 1/500 M were nearly as good. Sodium nitrate was next best, ammonium sulphate was very decidedly the poorest. In the early stages of growth ammonium nitrate was little better than ammonium sulphate, but given a longer time it became equal to potassium nitrate, and the latter was only slightly below sodium nitrate.

The different concentrations of the phosphate had little influence on the amount of growth, 1/10, 1/50 and 1/100 M being almost equally good, except that with cellulose as the carbon compound little growth was made with the concentration of the phosphate 1/50 or 1/100 M, while there was very good growth in 1/10 M.

Among the carbon compounds maltose was decidedly the best when ammonium nitrate was the source of nitrogen, but with calcium nitrate saccharose was as good or better. For all the three carbon compounds saccharose, dextrose and maltose, the concentration of 1 M was strongly inhibitive of growth. In 1/5 M the growth was far better than in any of less concentration. The experiments in which 2/5 M was used gave a slightly greater total than 1/5 M, but the rate of growth in the former was decidedly slower than in the latter. It was true in a good many sets of cultures that the rate of growth was more rapid in the more dilute solutions, though maximum growth occurred in more concentrated solutions.

Of the substances and concentrations tried the optimum medium for the fungus tested was:

Saccharose	2/5 M.
Calcium nitrate	1/250 M.
Monopotassium phosphate ...	1/10–1/100 M.
Magnesium sulphate	1/1000 M.

Saccharose has one very decided advantage over both dextrose and maltose. It may be obtained in a purer form. The ordinary rock candy obtainable at any candy store is far more nearly chemically pure than the grades of maltose and dextrose obtained from reliable dealers and labeled C.P. This is a very decided advantage in critical culture experiments.

A Labeling Surface for Laboratory Glassware: A. F. BLAKESLEE, Carnegie Institution.

Diamond ink applied to glassware gives a permanent ground-glass surface upon which labels can be written with lead pencil. Labels upon this surface are of especial value upon flasks, test tubes, etc., that need to be sterilized in autoclav.

GEORGE T. MOORE,
Secretary

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 465th regular meeting of the Anthropological Society of Washington, D. C., was held at Room 43 of the new building of the National Museum at 4:30 P.M., January 21, 1913, Mr. George R. Stetson, the president, in the chair.

Dr. Tom. A. Williams, M.B., C. H. Edin., M. Corresp. Etrang. Soc. de Neurologie de Paris, Soc. de Psychol. de Paris, etc., charter M. Am. Psychopath. Assoc., Collaborator *Jour. Abnorm. Psychol.*, read a paper on "The Dream in the Life of the Mind."

Trance, vision, ecstasy and disease-delirium are closely allied to the dream state. The psychopathology of them all illuminates formerly uncomprehended diseases. In a dream (illustrated by a case) mental perturbation may crystallize, as it were, and lead to rampageous behavior. On the contrary, dreams may be teleologically beneficial; as where a vision saved a young woman from suicide, as was the case also with Benvenuto Cellini.

They are more often a mere reproduction of former experiences, more or less significant and more so in psychopathic individuals, such as in a young hysteric who dreamed of falling down wells, assassinations and deaths, all painful experiences of her childhood.

Their sexual nature, believed inevitable by a certain school, is not so regarded by the author.

Nor is their analysis an essential of proper diagnosis and treatment of psychopathies. But in some cases they render the investigation more easy.

Dream-thought, apparently confused, is really significant of the mental trend of the individual, when properly analyzed and interpreted. One dreams all the time, but recollects only that within seven minutes of waking. The form of dream can be determined by external stimuli. This is demonstrated in spite of its contradiction by some psychopathologists.

A special meeting of the Anthropological Society of Washington was held on February 4, 1913, at 4:30 P.M. in Room 43 of the new building of the National Museum, the president, Mr. George R. Stetson, in the chair.

Dr. Clark Wissler, curator of the department of anthropology in the American Museum of Nattural History, New York, read a very elaborate and philosophical paper on the "Doctrine of Evolution and Anthropology."

An attempt was made to distinguish between cultural phenomena on one hand and biological on the other, especially to make clear that cultural phenomena are not inherited, though the instinct to develop culture, or to invent, is most certainly inborn. It was suggested that the historical attitude of present-day anthropology should be taken as expressing the cultural point of view. Culture itself seems to be associated habit complexes or constructs of the mind and not to be in any way innate or inborn, but to be an external affair, preserved and carried on entirely by learning or educating processes. Cultures develop and have an evolution of their own, but since they are not inherited they can not be considered parts of a biological development. They are most assuredly facts of another order. Being products of the mind, the only limitations put upon them are to be sought in the mind itself and since psychologists tell us that we have in the main only an associated cultural whole, resolvable into psychological elements and since this, in turn, is only a matter of invention and not of cell differentiation. Being a matter of invention, the genetic relationship becomes purely a matter of history, since we can not foretell what the relationship is.

The psycho-physical mechanism of man is biological and innate and constitutes man's equipment for the production of cultures. Anthropology holds that the mechanism is general in so far as it is not limited to any particular culture, and that it enables the individual to practise any culture he may meet, though not necessarily to equal degrees.

When we come to consider the biological theory of evolution we find that it applies to the psycho-physical mechanism but not to culture. For cultures we must have another point of view or theory and this in America, at least, is the historical or cultural conception. This conception is in general that cultural traits are the results of invention, a mental process, and their development or evolution is to be taken as a historical and psychological problem.

The paper was briefly discussed by Dr. Folkmar, Dr. Swanton and Dr. Hough.

Wm. H. Babcock,
Secretary

PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA
MATHEMATICAL AND SCIENTIFIC SECTION

The third meeting of the session 1912–13 of the Mathematical and Scientific Section was held on December 16.

Professor A. H. Tuttle made a preliminary report of work now in progress upon the life-history of the Charales, based chiefly upon cytological studies of a species of *Tolypella*.

The fourth meeting of the session 1912–13 of the Mathematical and Scientific Section was held on January 20.

Professor J. T. Singewald, of the Johns Hopkins University, read a paper on "The Titaniferous Ores of the United States."

Wm. A. Kepner,
Secretary

University of Virginia

THE ELISHA MITCHELL SCIENTIFIC SOCIETY

The 203d meeting of the society was held in Chemistry Hall, University of North Carolina, on Tuesday evening, February 11. The following program was presented:

"Photography of Sound Waves," by Mr. A. H. Patterson.

"Difference in the Effect of Grehant's Anesthetic and of Morphine Ether on the Output of Urine by Nephritic Animals," by Dr. W. B. MacNider.

"The Chemical Action of Light," by Dr. A. S. Wheeler.

James M. Bell,
Recording Secretary

Chapel Hill, N. C.